Newport Coast
Flow and Water Quality Assessment

Final Report

Prepared For:

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June 2006

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LIST OF ACRONYMS

ATSDR	Agency for Toxic Substances and Disease Registry
BG 1-7	Buck Gully sampling stations
BGC	Former Buck Gully sampling station (now BG6)
BGU	Former Buck Gully sampling station (now BG7)
BGO	Buck Gully ocean sampling station
CCC	Criterion continuous concentration
CDFG	California Department of Fish and Game
CMC	Criterion maximum concentration
CTR	California Toxics Rule
DO	Dissolved oxygen
ECH	Former Buck Gully sampling station (now BG2)
EMD	El Morro Canyon Creek downstream sampling station
EMT	El Morro Canyon Creek sampling station
GIS	Geographical information system
IRWD	Irvine Ranch Water District
LCB	Former Buck Gully sampling station (now BG1)
LOEC	Lowest observable effects concentration
LT	Los Trancos Creek sampling station used by the Irvine Co.
LTD	Los Trancos Creek downstream sampling station
LTU	Los Trancos Creek upstream sampling station
MCC	Muddy Canyon Creek sampling station
MCD	Morning Canyon downstream sampling station
MCU	Morning Canyon upstream sampling station
MLS	Mass loading station
MPN	Most probable number
MUN	Municipal or domestic use water quality objective
NOEC	No observable effects concentration
PAH	Polynuclear aromatic hydrocarbons
PCB	Polychlorinated biphenyl
pH	Hydrogen ion concentration
PP1	Pelican Point sampling location
PPC	Pelican Point Creek sampling station
PPM	Pelican Point Middle Creek sampling station
PPW	Pelican Point Waterfall Creek sampling station
PPY	Former Buck Gully sampling station (now BG3)
QA/QC	Quality assurance/ quality control
REC 1	Recreational 1 water quality objective
REC 2	Recreational 2 water quality objective
RPD	Relative percent difference
SGR	Former Buck Gully sampling station (now BG4)
SJH	Former Buck Gully sampling station (now BG5)
SS	Settleable solids
SWAMP	Surface Water Ambient Monitoring Program
SWRCB	State Water Resources Control Board
TDS	Total dissolved solids
TMDL	Total maximum daily load
TOC	Total organic carbon
TSS	Total suspended solids
USDA	United States Department of Agriculture

USEPA	United States Environmental Protection Agency
USGS	United States Geological Service
VOC	Volatile organic compound
WQO	Water quality objective

Executive Summary

1.0 INTRODUCTION

Weston Solutions, Inc. (Weston), under contract with the City of Newport Beach, has prepared this Draft Report for the Newport Coast Flow and Water Quality Assessment. The Newport Coast Flow and Water Quality Assessment are in accordance with the grant agreements under the State Water Quality Control Board Proposition 13 grant program. The assessment findings support the information requests for the Newport Coast Watershed Program (04-191-558-0) and the Little Corona/Buck Gully Habitat and Water Quality Improvement Project (02-204-558-0).

1.1 Objective

The objective of the Newport Coast Flow and Water Quality Assessment was to conduct a one-year assessment of eight coast canyon streams in the Newport Coast to address key management questions and to provide initial data to assist in future management decisions. The key management questions to be addressed by the Newport Coast Flow and Water Quality Assessment are:

- Are conditions in Buck Gully Creek, the seven other canyon streams, and the two Areas of Special Biological Significance (ASBSs) of the Newport Coast protective, or likely to be protective of their beneficial uses?
- What is the extent and magnitude of the current or potential problems in the eight Newport Coast canyons and the two ASBSs where these creeks flow into?
- What is the relative urban runoff contribution to the problems in the eight coastal canyons and the ASBSs?
- What are the sources to urban runoff that contribute to the water quality concerns in the largest and most developed canyon, Buck Gully?
- Are conditions in the eight coastal canyons and two ASBSs getting better or worse?

The results of the program presented in this report include a comparison of the constituent concentrations and loadings between coastal canyons that are in various stages of development. Comparisons are also made between constituent concentrations of ocean plume samples with the freshwater effluent at the mouth. Finally, this report presents recommended management actions to reduce estimated constituent loadings that may impact the designated beneficial uses of the canyon creeks and ASBSs. Recommendations for further study to prioritize and further define management actions are also provided.

1.2 Background

Figure 1-1 presents an overview of the Newport Coast Watershed. The Newport Coast Watershed covers approximately ten square miles and extends south of Corona Del Mar to El Morro Canyon. The majority of the watershed was annexed by the City of Newport Beach on January 1, 2002. The watershed includes eight canyon streams, seven of which are within the City of Newport Beach boundaries. These seven streams are Buck Gully Creek, Morning Canyon Creek, Pelican Point Creek, Pelican Point Middle Creek, Pelican Point Waterfall Creek, Los Trancos Creek and Muddy Creek. The eighth stream, El Morro Creek, is located outside of the Regional Water Quality Control Board (RWQCB) Region 8 and the City of Newport Beach, but is included in the Newport Coast Watershed Plan. El Morro Creek, which is part of the Laguna Coast Wilderness Park, provides a reference canyon in for natural background conditions for most of its length.

Rapid development and increased public use in the Newport Coast Watershed have led to problems involving urban runoff, streambed instability, slope failures, erosion, invasive plants, and the loss of riparian habitat. Downstream portions of Buck Gully Creek and Los Trancos (Crystal Cove Creek) are listed on the CWA Section 303(d) List of Water Quality Limited Segments for total and fecal coliforms (RWQCB 2003). The Newport Coast Watershed Management Initiative states that Buck Gully Creek, Pelican Point Creek, Los Trancos and Muddy Creek are in violation of one or more of the following beneficial uses: REC 1, REC 2, and MUN (RWQCB 2004).

In addition, this coastline has two Area of Special Biological Significance (ASBS) designations; the Newport Beach (Robert E. Badham) Marine Life Refuge (ASBS No. 32) and the Irvine Coast Marine Life Refuge (ASBS No. 33). Enacted in the mid-1970's to protect marine life from undesirable changes in natural water quality, the ASBS designation is based upon the presence of certain species or biological communities that, because of their value or fragility, deserve special protection consisting of preserving and maintaining natural water quality conditions to the extent practicable (SWRCB 1972). In 2003, these areas were renamed State Water Quality Protection Areas (SWQPA). In 2005, a Senate Bill clarified the language and stated that ASBSs are considered to be subsets of SWQPAs, meaning that waste discharges to ASBSs are prohibited under the Ocean Plan and Thermal Plan unless an exception is granted (Senate Bill 512, Chapter 854, Statutes of 2004).

These ASBSs also have Critical Coastal Area (CCA) designations for the adjacent land, as well. The Newport Beach Marine Life Refuge (CCA #70) and the Irvine Coast Marine Wildlife Refuge (CCA #71, shared with Region 9) are designated areas requiring protection of species or biological communities to the extent that alteration of natural water quality is undesirable (RWQCB 2004). The California Ocean Plan states that point and non-point source discharges of waste into these areas are prohibited.

The long-term goals of the watershed program are to reduce negative impacts, where identified, to the ASBSs, stabilize and restore the watershed canyons as needed, and create the groundwork for restoration, maintenance, and community outreach programs. In order to protect sensitive marine life areas along the Newport Coast from potential negative impacts, an understanding of wet and dry weather flows from the canyon watersheds that discharge to the ASBS is needed. The Newport Coast Flow and Water Quality Assessment is the first step towards these goals.

A detailed description of the objectives, scope and methodologies for the Newport Coast Flow and Water Quality Assessment are presented in the Final Monitoring Plan and Quality Assurance Project Plan (QAPP) (Weston 2005) which was approved by the Santa Ana Regional Water Quality Control Board (Regional Board) on September 15, 2005. Using the flexibility allowed through adaptive management to best answer the key questions; modifications to the Monitoring Plan were proposed in January 2006 (Weston 2006) and approved by the Regional Board on March 20, 2006.

This report provides a summary of the methods used in the assessment, modifications from the QAPP, the results, conclusions, and recommendations for further assessments or management actions. The Methods section includes site locations, sampling frequency, sampling methods, and the methods for data analysis. The Results section presents the field and analytical data which includes the results of the quality control samples, the dry and weather sampling events, and the Buck Gully Source Investigation. The section also presents select constituent loadings based on the results of this assessment. Conclusions and recommendations are then presented. The appendices contain the field data sheets and all laboratory reports from the assessment.

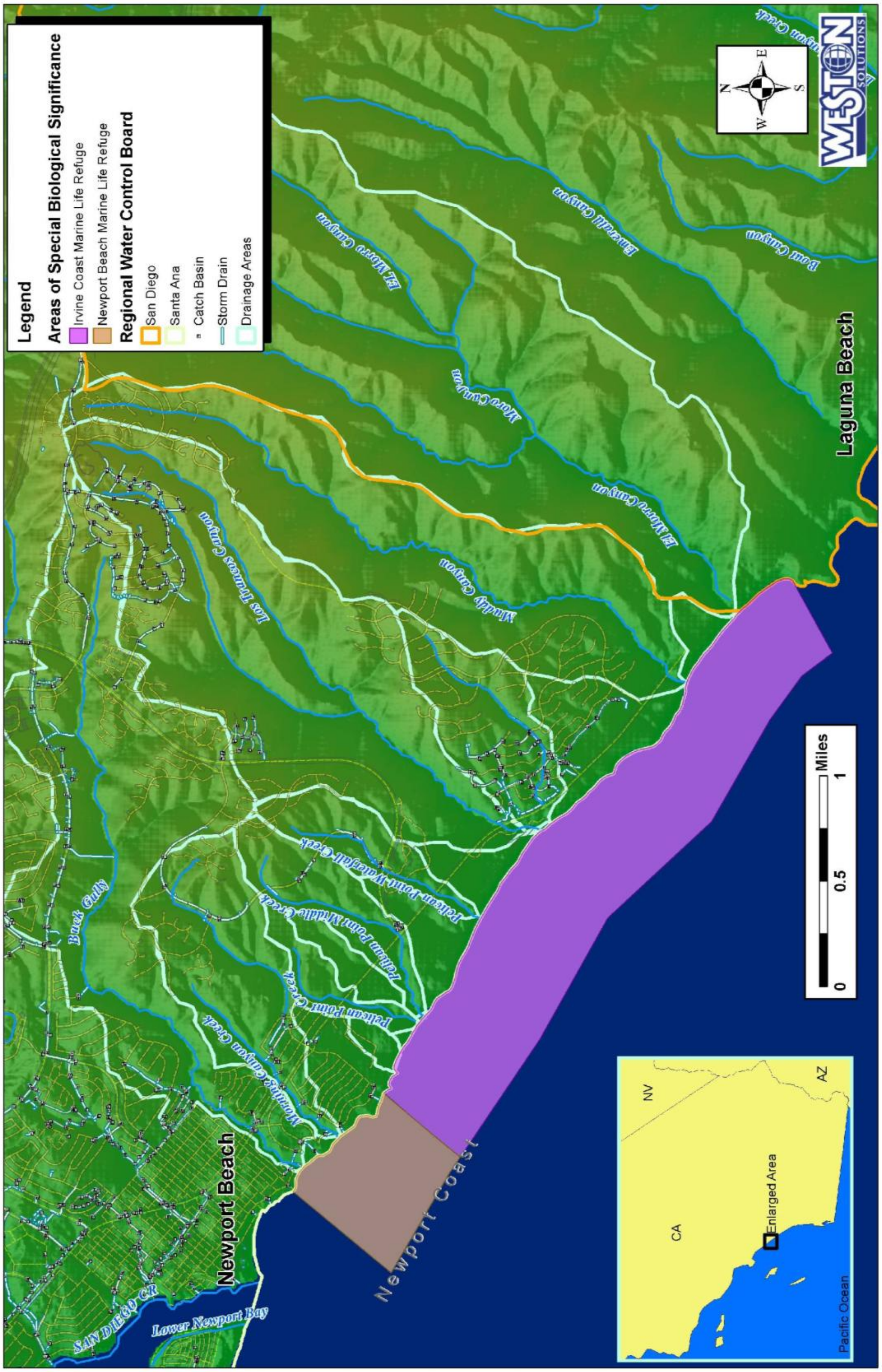


Figure 1-1. Newport Coast overview.

2.0 METHODS

The Newport Coast Flow and Water Quality Assessment included a field and analytical laboratory program consisting of a series of wet weather and dry weather sampling events. During these events, flow data was obtained using both installed and hand held equipment. Water quality samples were collected using automated sampling equipment and grab sampling techniques and were then sent to the appropriate laboratory for chemistry, bacterial, toxicity, and QC analysis. In addition, temperature, dissolved oxygen, pH, and conductivity were analyzed in the field.

The detailed methodologies are found in the QAPP (Weston 2005). This section provides a brief overview of the methodologies used and focuses on any deviations from the QAPP as needed, per the adaptive management technique. As described in the QAPP, the adaptive management technique was employed to provide flexibility to adjust protocol as necessary in response to information obtained during the course of the study to most effectively address the assessment objectives.

2.1 Site Locations

Figure 2-1 and Table 2-1 presents the site locations and a brief description of the Newport Coast Flow and Water Quality Assessment. The assessment focuses upon eight canyon streams that comprise the Newport Coast Watershed. Seven of these streams, Buck Gully Creek, Morning Canyon Creek, Pelican Point Creek, Pelican Point Middle Creek, Pelican Point Waterfall Creek, Los Trancos Creek, and Muddy Creek, are located within the City of Newport Beach. The remaining creek, El Morro Creek is in Crystal Cove State Park, and provides a relatively undeveloped local watershed to serve as a reference to the more developed canyons to the north.

Table 2-1. Summary of final site locations for the Newport Coast Flow and Water Quality Assessment.

Site ID	Stream	Description
BGO	Ocean; Buck Gully outfall	Ocean mixing zone at Buck Gully outfall.
BG1	Buck Gully	At concrete weir on Little Corona Beach.
BG2	Buck Gully	Downstream of Coast Highway.
BG3	Buck Gully	In stream at Poppy and 5th Avenue.
BG4	Buck Gully	Downstream of Spyglass Ridge Community outfall.
BG5	Buck Gully	Upstream of San Joaquin Hills Road outfall at end of walking path.
BG6	Buck Gully	Downstream of corrugated pipe outfall on fire road.

Site ID	Stream	Description
BG7	Buck Gully	Downstream of Newport Coast Road and first MS4 outfall.
MCD	Morning Canyon Creek	On beach at mouth of Morning Canyon Creek.
MCU	Morning Canyon Creek	Upstream of where the creek is diverted into the storm drain system off of Surrey Drive.
PP1	Storm drain outfall (Pelican Point)	On beach in Crystal Cove State Park downstream of Pelican Point gated community.
PPM	Pelican Point Middle Creek	From waterfall falling onto the beach in Crystal Cove State Park.
PPW	Pelican Point Waterfall Creek	On beach in Crystal Cove State Park.
LTD	Los Trancos Creek	Upstream of pooled/bermed area downstream of the Coast Highway.
LTU	Los Trancos Creek	Upstream of the diversion in Crystal Cove State Park.
MCC	Muddy Canyon Creek	Upstream of the diversion of Muddy Canyon Creek.
EMO	Ocean; El Morro Creek outfall	Ocean mixing zone at El Morro Creek outfall.
EMD	El Morro Creek	Upstream of tidal influence in the El Morro Trailer Park.
EMT	El Morro Creek	Upstream of the El Morro Trailer Park. (Bacteria samples only)
EMU	El Morro Creek	Downstream of the confluence of two tributaries in Crystal Cove State Park.

Site locations are described in more detail in the QAPP. Some site locations were modified based on actual field conditions to better assess both surface water and groundwater seepage inputs along the canyon creek. Site assessments were made and additional information was gathered which led to these location modifications. In addition, the Buck Gully station names were changed to better identify the seven sites within the canyon (Table 2-2).

Table 2-2. Buck Gully Station ID Changes.

Previous station ID	Current station ID
LCB	BG1
ECH	BG2
PPY	BG3
SGR	BG4
SJH	BG5
BGC	BG6
BGU	BG7

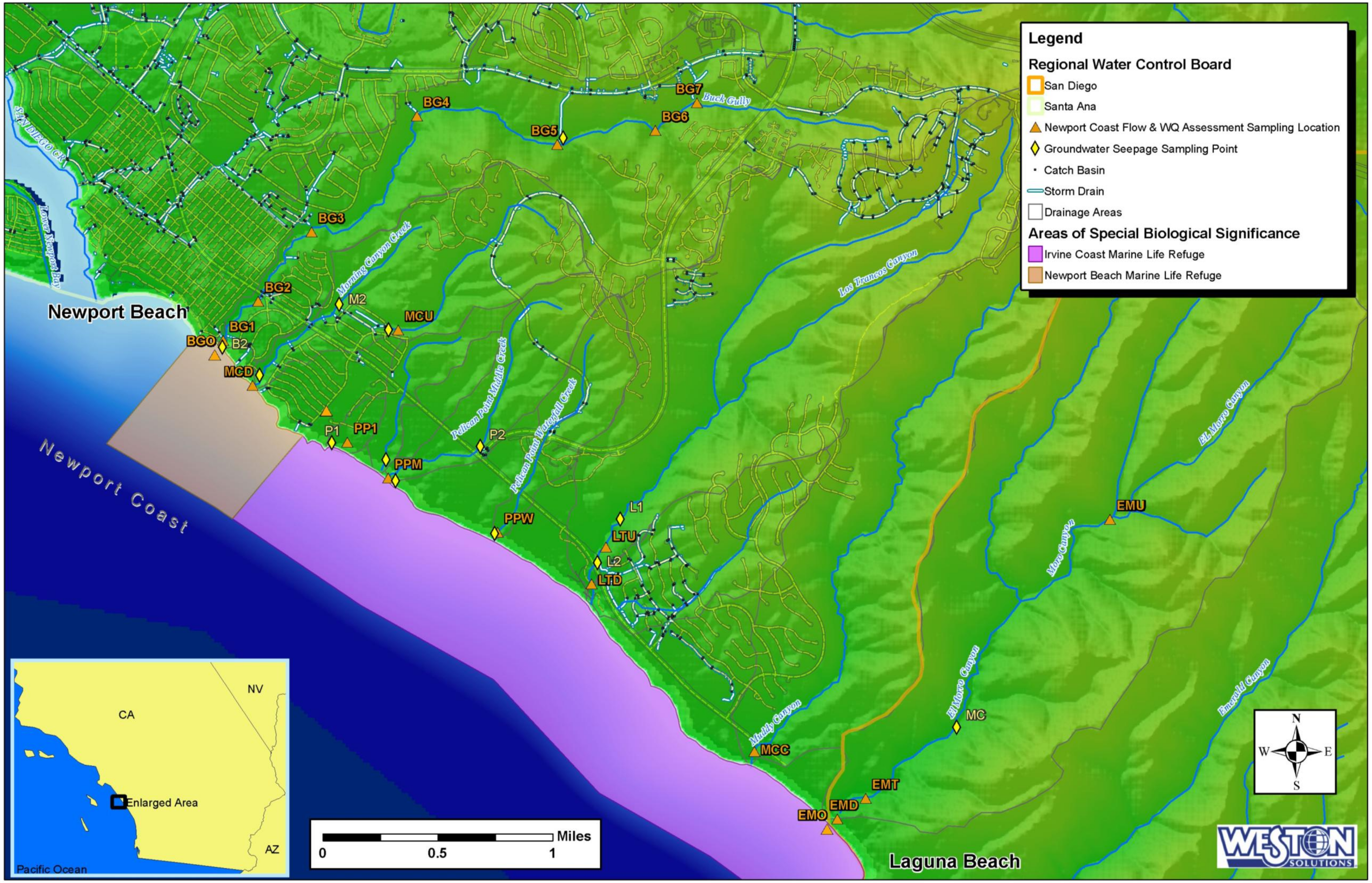


Figure 2-1. Site locations of the Newport Coast Flow and Water Quality Assessment.

The following is a list of site location changes within Buck Gully:

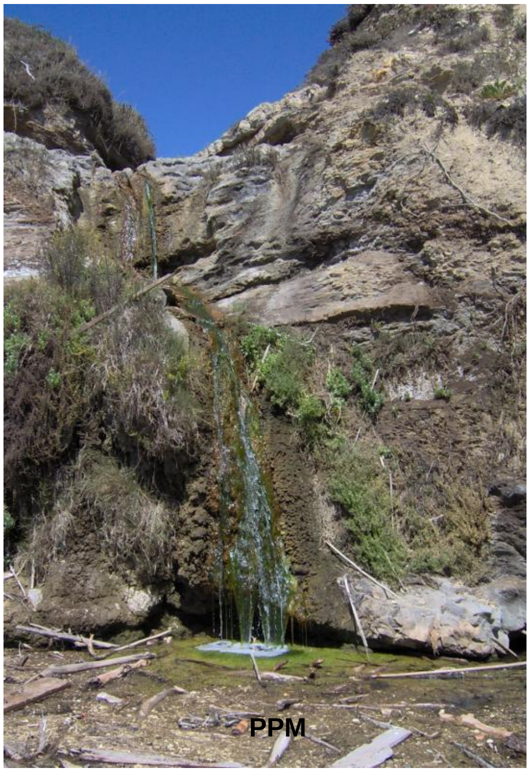
- **BG3** (PPY) was changed to sample Buck Gully in the main channel as opposed to the effluent from the storm drain entering Buck Gully at this location. The new sampling location was downstream of the access road. This provides a better assessment of Buck Gully as it moves downstream. The sources influencing Buck Gully, including this storm drain, were sampled during the Buck Gully Source Investigation.

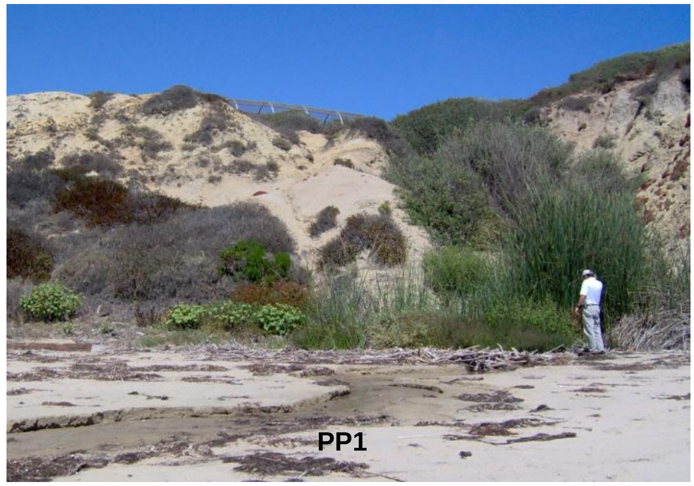
- **BG4** (SGR) was changed from sampling storm drain flow from the Spyglass Ridge community to a location in Buck Gully just downstream of the storm drain outfall. A path leads upstream from BG3 to the new BG4 sampling location.

- **BG5** (SJH) was located at the same general location as described in the QAPP, but was taken downstream of the confluence of the drainage from the community and the main stream.

- **BG7** (BGU) was added as the furthest upstream site. It is located downstream of Newport Coast Drive, but upstream of the first storm drain input from San Joaquin Hills Drive.

The initial dry weather survey revealed that two of the Pelican Point Creeks have intermittent seasonal flows. Pelican Point Creek (PPC) and Pelican Point Waterfall Creek (PPW) only have flow associated with wet weather. Pelican Point Middle Creek (PPM) has perennial flow. Thus, the two dry season creeks were not sampled during either of the dry weather events. However, another outfall with dry weather flow was found and identified as PP1, north of PPC. The PP1 outfall had a consistently higher flow than that of PPC during wet weather, as well, therefore, PP1 was sampled during the dry and wet surveys.





The El Moro Downstream site (EMD) was initially located upstream of a trailer park. However, two septic leach fields upstream were discovered. An attempt to sample upstream of the leach fields was made, to avoid anthropogenic influence on the sample, but the streambed was dry. Therefore, as presented in Figure 2-1, the site was moved downstream to assess total constituent loading entering the ASBS.

At the original mass loading station site, an additional site, EMT, was added (Figure 2-1). This site was sampled only for bacteria to provide data about bacteria loading potentially associated with the septic leach fields.

2.2 Sample Frequency

As detailed in the QAPP, two dry weather events, two wet weather events, and the Buck Gully Source Investigation were originally scheduled for the assessment. The initial sampling design was modified as a result of data collected in the first dry and wet weather sampling events. These surveys provided data that suggested that the highest concentrations and number of constituents were associated with the wet weather flows. Furthermore, to properly evaluate the variance in detected constituent concentrations, three wet weather events were sampled. The amended Newport Coast Flow and Water Quality Assessment included one full dry weather sampling event, one modified dry weather sampling event, three wet weather sampling events, and the Buck Gully Source Investigation. The sampling protocol was amended and approved by the City of Newport Beach and the Santa Ana Regional Water Quality Control Board on March 20, 2006.

In order to provide a trade-off to better address the key questions, the second dry weather event was modified to focus on Buck Gully and El Morro Canyons. Although the sampling results during dry weather had fewer exceedances of water quality objectives, urban runoff remains a concern, particularly in the most developed canyon, Buck Gully. In Buck Gully, the first dry weather sampling event was a comprehensive survey of all seven of the sampling locations. As part of the amendments to the Monitoring Plan, dry weather grab samples were taken at four locations in Buck Gully and two locations in El Morro Canyon for a modified list of constituents.

An additional adjustment was made to create the resources needed to monitor three total storm events. Sampling was discontinued in Los Trancos and Muddy Creeks because stormwater sampling was already being conducted by the Irvine Company. The Irvine Company monitors these two creeks for the same constituents during wet weather. The data from the Irvine Company is included in this report for the third storm event. Figure 2-2 presents the Los Trancos site locations. Weston sampled Los Trancos Creek at LTU during the first dry weather event and LTD during the first wet weather event. Los Trancos flow is diverted just below the LTU site and is therefore dry downstream during dry weather. The Irvine Company samples Los Trancos at two sites east of the Pacific Coast Highway at their sites LTU and LT. The Irvine Company's LTU site is upstream of Weston's LTU site. The Irvine Company's LT site is downstream of Weston's LTU site within 10 feet. However, it does include an additional outfall flowing in between these two sites from the community southeast of Los Trancos.

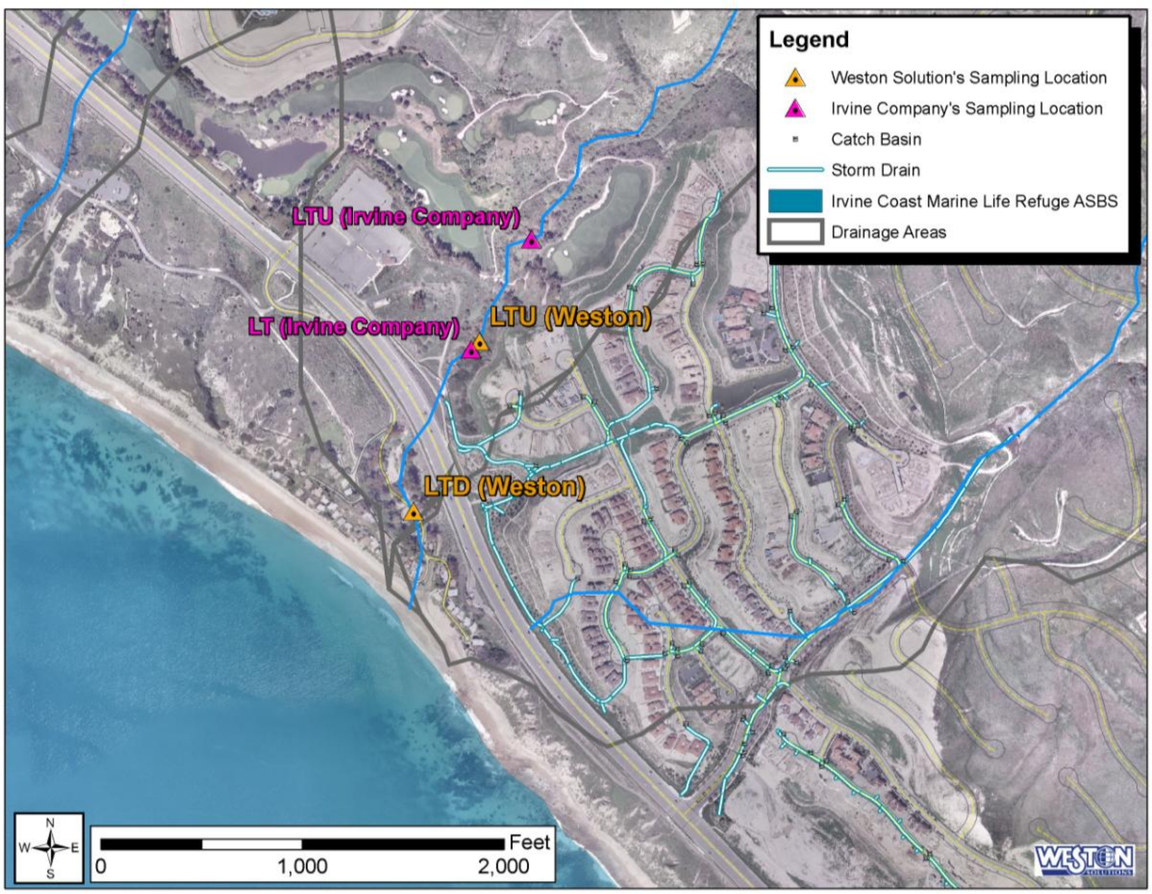


Figure 2-2. Los Trancos site location comparison.

2.3 Sampling Methodology

Detailed sampling methodology is available in the QAPP (Weston 2005). The following is an overview of the methods used and a description of any variances from the original methods outlined in the QAPP.

2.3.1 Water Quality

2.3.1.1 Dry Weather

During the first dry weather event, samples were collected at the two Mass Loading Stations (MLS) over a 24-hour period on Buck Gully (BG1) and El Morro Creek (EMD). Automated sampling equipment was used to collect flow-weighted composite samples. The samples were collected in 19-liter borosilicate glass bottles and kept on ice. Constituents that were not conducive to composite sampling techniques (bacteria, oil and grease, and VOCs) were collected by manual grabs. Four constituents were measured in the field (pH, conductivity, temperature, and DO). Field measurements were taken at the beginning, middle, and the end of the sampling events.

The remaining sampling locations were sampled for the first dry weather event and all of the sites for the second modified wet weather event using manual grab sampling techniques, typically with a telescoping grab sample pole. These samples were collected from the center of the channel.

A field data log was completed at each site. The completed dry weather event logs are presented in Appendix A.

Table 2-3 presents a summary of the constituents analyzed for the various sampling events. The composited samples were analyzed from the MLS sites for the 24-hour dry weather event for the expanded list of constituents based on the Ocean Plan. Samples were collected from the remaining locations and the second dry weather event and analyzed for the focused list of constituents.

2.3.1.2 Buck Gully Dry Weather Source Investigation

Potential dry weather sources were initially investigated during the first dry weather sampling event. Although this event focused on the collection of dry weather samples over a 24-hour period in Buck Gully, several potential dry weather sources were also identified and investigated. Based on the findings of the first dry weather sampling event, it was recommended that these potential sources be further investigated as part of a follow-up dry weather source identification survey.

At the seven original Buck Gully dry weather sites, basic water quality field measurements were collected. CHEMetrics brand field screening test kits were also used to measure concentrations of phosphate, nitrate, and ammonia in the effluent. Qualitative observations were also recorded. Utilizing existing information gathered during the first dry weather source investigation and by investigations in the field that day, potential dry weather sources that included storm drains and known tributaries were identified and investigated. For those sites with stream flow, the same water quality field measurements were taken (pH, dissolved oxygen, temperature, and conductivity).

Table 2-3. Summary of Constituents to by Analyzed by Event.

Analyte/Constituent Group	Focused List (Freshwater)	Full List Based on Ocean Plan (Freshwater)	Focused List for MLS (Freshwater)	Ocean Mixing Zone List (Saltwater)	QA/QC	
					Equip Blank	Field Dup
Ammonia	X	X	X	X		
Butyltins		X				
Chromium +6		X		X		
Gross Alpha and Beta		X				
Metals – Dissolved	X	X	X	X	X	
Metals – Total	X	X	X	X	X	
Nutrients (TKN, Nitrate, Nitrite, Total Phosphorus, Orthophosphate)	X	X	X	X		
Oil & Grease	X	X	X	X		
Organochlorine Pesticides/PCB		X		X		
Organophosphorus Pesticides	X	X	X	X	X	X
Residual Chlorine		X		X		
Semi-Volatile Compounds/BNA		X		X		
Synthetic Pyrethroids		X	X			
TCDD Equivalents (Dioxin)		X				
Total Cyanide		X		X		
Triazine Pesticides		X				
Volatile Organic Compounds		X		X		
Water Chemistry Parameters (Turbidity, TSS, TDS, SS, Hardness, TOC)	X	X	X	X		
Bacteria Indicators (Total Coliform, Fecal Coliform, Enterococcus, *E. coli*)	X	X	X	X		
Toxicity, Chronic				2nd wet		
Toxicity, Acute			3rd wet	2nd wet		
Visual Observations/Field Measurements	X	X	X	X		X
Sampling Event (Date)	**Number and List of Sampling Sites Analyzed for Above Listed Constituents**					
1st DRY (9/27-9/28)	13 BG2, BG3, BG4, BG5, BG6, BG7, MCD, MCU, PP1, PPM, LTU, MCC, EMU	2 BG1, EMD	0	2 BGO, EMO	0	1 LTU
1st WET (10/16-10/17)	9 BG3, BG7, MCD, MCU, PP1, PPM, PPW, LTD, MCC	2 BG1, EMD	0	2 BGO, EMO	0	1 BG3
DRY SOURCE ID (11/16)						
2nd DRY (2/13)	6 BG1, BG3, BG4, BG7, EMD, EMU	0	0	0	1 BG1	1 BG1
2nd WET (2/18-2/19)	7 BG3, BG7, MCD, MCU, PPM, PPW, PP1	0	2 BG1, EMD	BGO Residual Chlorine, TSS, Acute and Chronic Tox	0	1 BG3
3rd WET (2/27-2/28)	7 BG3, BG7, MCD, MCU, PPM, PPW, PP1	0	2 BG1, EMD (BG1 Acute Tox only)	0	0	1 BG3

A field data log was completed at each site. The completed Buck Gully Source Investigation logs are presented in Appendix A.

2.3.1.3 Wet Weather

During the three wet weather events, samples were collected at the two MLS on Buck Gully (BG1) and El Morro Creek (EMD) over the duration of the storm. Automated sampling equipment was used to collect flow-weighted composite samples. The samples were collected in 19-liter borosilicate glass bottles and kept on ice. Constituents that were not conducive to composite sampling techniques (bacteria, oil and grease, and VOCs) were collected by manual grabs. Four constituents were measured in the field (pH, conductivity, temperature, and DO) and were taken at the beginning, middle, and the end of the sampling events.

The remaining sampling locations were sampled for the all of the wet weather events using manual grab sampling techniques, typically with a telescoping grab sample pole. These samples were collected from the center of the channel, where possible. Safety concerns during wet weather often prevented samplers from reaching the horizontal center of the channel.

A field data log was completed at each site. The completed wet weather event logs are presented in Appendix A.

Table 2-3 presents a summary of the constituents analyzed for the various sampling events. The composited samples were analyzed from the MLS sites for the first wet weather event for the full list of constituents based on the Ocean Plan. Samples collected at the MLS sites for the second and third wet weather event were analyzed for the modified list of constituents plus synthetic pyrethroids and the ultra-low detection limit metals. The remaining sampling locations were analyzed for the modified list of constituents.

2.3.1.4 Ocean Sampling

The ocean mixing zone samples were collected and analyzed for chemistry during the first dry and first wet weather events. Ocean, chemistry samples were collected in 2-liter glass jars approximately 5 feet from the outfall in 2 feet of water depth (approximately 15 feet offshore). In addition, trace metals were collected using the clean-hands sampling technique separately in 1-liter polypropylene containers. The samples were collected from just below the surface of the water. Samples were collected from the ocean every three hours during the dry weather event and every two hours during the wet weather events. The samples were kept on ice and delivered to CRG Laboratories where they were composited equally and subsampled.

During the second wet weather event, ocean grabs for toxicity analysis were collected by filling a 10 liter glass jar at a consistent location approximately 5 feet from the outfall in 2 feet of water depth (approximately 15 feet offshore). Again, the samples were collected from just below the surface of the water. Samples were collected from the ocean every two hours throughout the sampling event and kept on ice. The ocean samples were then composited and delivered to Weston's in-house bioassay laboratory.

Ocean sampling methodology was in accordance with State Water Resources Control Board (SWRCB) criteria. Prior to sampling, several questions were posed to the State Board regarding

ASBS sampling techniques. These answers were included in a Frequently Asked Questions document which specified the following sampling protocol:

> "Preferably...sampling would take place immediately outside the surf zone. However…if vessel safety is an issue, you may collect the sample from the shore, generally adjacent to the point where runoff meets the ocean." (SWRCB 2006)

To estimate the approximate location sampled in the plume, the distance from the outfall and the salinity of the sampling location were recorded. The location of the sampling point was then identified and is presented in the Results section.

2.3.1.5 Quality Control

In accordance with the quality control guidelines in the Surface Water Ambient Monitoring Program (SWAMP) detailed in the QAPP, several QC procedures were applied in the monitoring program. Table 2-3 presents the field duplicate and equipment blank sampling.

As directed by SWAMP protocols, field duplicates were taken for organophosphate pesticides during each sampling event. In addition, during the second dry weather event, an equipment blank was taken at the Buck Gully MLS. The blank was analyzed for total and dissolved metals and for organophosphate pesticides.

In addition, all laboratory QC methods were followed by the certified laboratories and included in their reports (Appendices C, D, and E).

2.3.2 Flow Measurements

2.3.2.1 Hand Held Equipment

Stream flow was measured using portable flow measuring equipment with the exception of the MLS sites, Los Trancos and Muddy Creek. Initial hand held flow data was obtained using a Marsh-McBirney flow meter. For the Buck Gully Source Investigation, flow values were measured using a Son-Tek Flow Tracker. After the first dry event, it was determined that the Son-Tek was a more appropriate equipment given the site conditions.

During the first dry weather survey, accurate flow measurements were difficult to obtain due to the low flows and low suspended solids content of the creek. To remedy this, alternate portable flow meters were researched. The SonTek Flow Tracker was found to be better suited for the site conditions, and is the flow meter used by the United States Geological Survey (USGS). The Flow Tracker was field tested and Team members trained in a local stream before the dry weather source investigation. The apparent advantage of the Flow Tracker is the discharge is automatically calculated for the user and displayed on the hand-held unit along with a standard deviation and stream statistics, such as width, average flow, maximum flow, and depth. Selected values were recorded on the data sheets. The information was then downloaded and verified for quality assurance.

2.3.2.2 Installed equipment

American Sigma 950 flow meters were installed at the mouth of Buck Gully and El Morro Canyon. Los Trancos canyon flow data was obtained using an American Sigma 920 flow meter.

2.3.2.3 Modeled Flow

The outfall of Buck Gully to Little Corona Beach changed with each storm event. Variability in the streambed led to variability in flow measurements. To verify flow measurements, flow data was modeled using nearby United States Geological Survey (USGS) gage stations.

Yearly flow predictions for Los Trancos Canyon and Buck Gully sites were modeled using available data and four nearby USGS flow gaging stations. As stated previously, the stream channel at the mouth of Buck Gully varied during and between storm events resulting in highly variable flow measurements. Flow modeling was conducted to develop an annual flow and annual loading estimates. Modeling of the flows at El Morro was also conducted. However, the baseline flow data at El Morro canyon showed excessive drift over the course of the monitoring time period and no significant relationship between this station and the four USGS flow stations was found. Therefore, an annual hydrograph for El Moro could not be produced.

A predictive stream flow model was developed using multiple regression techniques. Hourly continuous flow data were used from the periods of February 15, 2006 to March 18, 2006 at Buck Gully, and November 1, 2005 through March 18, 2006 from Los Trancos. Stream flow data from four USGS stations were selected based upon proximity to the area, fewest diversions, and little or no regulation of flow. Continuous data for the four sites included the time period from January 1, 2005 through March 20, 2006.

A short summary from the USGS website describes the four sites as follows:

- Bonita Creek at Irvine (USGS Station #11048600) has no upstream diversion with some regulation related to a small storage reservoir upstream. Irrigation flow may cause dry weather low-flow variability.

- San Juan Creek at San Juan Capistrano (USGS Station #11046530) has no regulation upstream, although Capistrano Water Company diverts water 2.0 miles above the station and this water may return as irrigation flow during dry periods.

- Arroyo Trabuco at San Juan Capistrano (USGS Station #11047300 is not subject to any upstream diversion or regulation.

- Sand Canyon at Irvine (USGS Station #11048553) may be influenced by irregular treated wastewater flows from Sand Canyon Reservoir, but has no upstream diversions.

Multiple regressions were completed using the statistical software package R. Stream flow data from the four USGS stations was used for independent variables. These data did not show a normal distribution required of the statistical test. Therefore, all data for the time period stated above were natural log transformed prior to the multiple regression analysis. This analysis resulted in acceptable prediction performance for Buck Gully flow (R^2 of 0.78 and p-value

<0.001) and Los Trancos flow (R^2 of 0.74 and p-value <0.001). The residuals of the regressions were checked for normality, and histograms of both indicated the residuals were normally distributed. Regressions of flow data from El Moro were not statistically significant. As such, flows of El Moro were not predicted.

A fit of the data to predicted flows for the time periods above resulted in a relative error (∑(actual flow – predicted flow) / ∑ actual flow)) of 3% for Buck Gully and 7% for Los Trancos. A standard error of estimate (s_e) was also calculated, with a s_e of 0.12 for Buck Gully and 1.01 for Los Trancos. This means that approximately two-thirds of the predicted flows are within the s_e of the predicted value and 95% of the predictions are within two standard errors (0.24 or 2.02 respectively) of the actual flow. The flows for Buck Gully and Los Trancos were predicted over an entire year period to calculate annual loadings.

2.4 Data Analysis

2.4.1 Analytical Data

Comparisons of analytical data are presented in this report on two levels; a cross-watershed comparison and a comparison to applicable water quality objectives (WQOs). Due to the relative lack of urbanization in El Morro Canyon, the results of El Morro Creek were used as a reference in which to compare the other, more developed, coastal canyons. Constituent concentrations were compared to the following WQOs:

<u>Freshwater Creek Samples</u>

- Santa Ana River Basin Plan (RWCQB 1995)
- Title 40 of the Code of Federal Regulations Part 131 (“California Toxics Rule”) (USEPA 2000)
- Water Quality Criteria for Diazinon and Chlorpyrifos (Siepmann and Finlayson 2000, CDFG)

<u>Saltwater Mixing Zone Samples</u>

- California Ocean Plan (SWRCB 2001)

Appendix B contains an updated table from the QAPP detailing the WQOs used in the analysis of data. It is noted that in the analysis of metals, Title 40 of the Code of Federal Regulations Part 131 (“California Toxics Rule”) (USEPA 2000) will apply to the freshwater samples. The California Toxics Rule (CTR) criteria for metals are adjusted depending on the hardness of the water. There are two sets of criteria; one for acute and the other for chronic exposure. The acute criterion is the California Toxic’s Rule Criterion Maximum Concentration (CTR CMC) defined as a short-term concentration limit. This criterion is used for the wet weather events due to their short duration, which corresponds to an acute (short-term) type exposure. The chronic criterion is the California Toxic’s Rule Criterion Continuous Concentration (CTR CCC) defined as a four-day average concentration limit. As discussed in the QAPP, due to resource limitations, it is understood that the 24-hour composite or grab sample techniques may not fully represent a long-term chronic condition, but it does provide an initial assessment to determine if a water quality issue exists for dry weather flows. The CTR CCC is used to compare dry weather metal’s results due the longer duration of the flows, which correspond to a chronic (long-term) exposure.

In addition to the acute and chronic WQOs, the CTR provides WQOs for both the total and dissolved recoverable forms of metals. However, the WQOs for freshwater are based on dissolved metals which are generally more bio-available to potential ecological receptors and will therefore be used as the primary reference for metals toxicity in freshwater. The Ocean Plan, however, uses the total recoverable form of the metals for the WQOs. Therefore, for saltwater samples, the total metals result will be discussed and compared to the Ocean Plan WQOs.

The Santa Ana Basin Plan provides a water quality objective for fecal coliforms for REC-1 inland waters as a 30-day mean:

> *Fecal Coliform: log mean less than 200 organisms/100mL based on five or more samples/30 day period, and not more than 10% of samples exceed 400 organisms/100mL for any 30-day period* (RWCQB 1995).

Although the number of samples in this assessment did not allow for a mean to be calculated, a conservative approach is taken and a single sample results is considered an exceedance at a value greater than 400MPN/100mL.

The Basin Plan does not provide a water quality objective for Enterococci for inland surface waters. The Ocean Plan water quality objective of 104 MPN/100mL is provided as a reference; however, freshwater samples are not considered an exceedance if a single sample is above this value.

2.4.2 Loading

2.4.2.1 Load Duration Curves

Load duration curves are useful in a number of ways. They are most often used to provide a visual understanding of the frequency and magnitude of pollutant loads in relation to water quality objectives. They are used to characterize the flow conditions under which exceedances of water quality objectives are occurring. Different loading mechanisms can dominate at different flow regimes. The load duration curve can be used to begin differentiating between non-point and point source problems. Exceedances of the load duration curve during higher flows are most often indicative of non-point source problems. Load duration curve exceedances in low flow periods can indicate point source issues. Load duration curves can also show seasonal water quality effects. Data points that cluster within a narrow range can be associated with a particular season that those flows occur.

Load Duration Curves for Buck Gully and Los Trancos Canyon were developed using the predicted flows generated from the multiple regression model for the time period of March 15, 2005 through March 15, 2006 as discussed in Subsection 2.3.2.3. The first step in the development of the Load Duration Curves is creating Flow Duration Curves. The Flow Duration Curve is generated using the predicted flows from the regression model and then ranking the daily flow from highest to lowest, and finally calculating the number of days the flows were exceeded (Nevada Division of Environmental Protection 2003). The Load Duration Curve is then developed by multiplying the Flow Duration Curve by the water quality standard of interest and a unit conversion factor (Equations 1 and 2). A unit conversion factor is needed to convert flow and concentration into pounds per day.

$$\textit{Load (pounds per day)=stream flow (cfs) x } \mu g/L \textit{ x 0.00538} \quad (1)$$

$$\textit{Load (MPN per day)=stream flow (cfs) x MPN/100mL x 24,465,755} \quad (2)$$

Constituents included in the development of the Load Duration Curves were dissolved cadmium, copper, lead, zinc, Fecal Coliform, and Enterococcus. These constituents were selected for loading analysis because they exceeded the water quality objectives. Water quality standards for dissolved and total metals are based on a calculation that includes water hardness. The average concentration of samples collected and analyzed for each sampling location was used to determine compliance with dissolved and total metal's WQOs. A water quality criterion for Fecal Coliform and Enterococcus of 400 MPN/100mL and 104 MPN/100mL, respectively, were used for the bacterial Load Duration Curves. Although the Santa Ana Basin Plan does not provide a water quality objective for Enterococcus, the Ocean Plan objective of 104 MPN/100mL is used as a reference value.

Wet weather data for sites Los Trancos (LTD) and Muddy Creek (MCC) were collected by Weston for the first wet weather event. As discussed in Section 2.2, the Irvine Company collected wet weather chemistry and flow at Muddy Creek and an upstream Los Trancos site at three additional wet weather events. To determine if data provided by the Irvine Company for Los Trancos was similar to the Weston results, a comparison was made of the Irvine Company's dissolved and total metals and bacterial results with Weston's results. This comparison was performed by calculating a 95% confidence interval using the Irvine Company's data, which consisted of three samples, compared to the one sample Weston data set. Based on this statistical comparison, if the Weston data fell within the confidence bounds, then it was deemed usable. Results Section 3.1.3 presents Figure 3-19 through Figure 3-24 that show the Irvine data plotted with confidence bounds, along with the Weston chemistry and bacterial data (open squares). All constituents assessed, except bacterial indicators, were identified as statistically comparable (fell within the 95% confidence interval), and were used in the loading calculations. Therefore, bacterial data from the Irvine Company were not used in any wet weather load calculations for Muddy Creek or Los Trancos. Only Weston bacterial data were used.

The Load Duration Curves show the actual water quality data for Buck Gully and Los Trancos. These data are represented using the average daily flow for the day on which the sample was collected, multiplied by the constituent concentration reported for the sample and unit conversion factor. The actual "sample day" data are plotted using the rank of the daily flow and daily load. Data from the Irvine Company are also included, to make a total of five samples plotted on the Los Trancos Load Duration Curves. The purpose of plotting the actual data is for comparison to the Load Duration Curve. Samples that appear above the curve exceed the allowable load based on the applicable water quality objective.

2.4.2.2 Annual Loads

Calculation of contaminant loads was undertaken because analysis of only contaminant concentrations can be misrepresentative when making management decisions, determining the source of a contaminant, or establishing whether a contaminant problem is related to dry or wet weather. A high concentration at low flows, or conversely a low concentration at high flows, can misrepresent the total amount of a pollutant being discharged to the environment. Therefore, it is important to calculate a load that can be used to compare between sites, whether they are high flow or low flow sites, large or small canyons. In this way, it is possible to compare annual, wet and dry weather loads between canyons. In addition, management measures should be developed based on load reductions to receiving waters using source control and pollution prevention measures and, where necessary, treatment controls.

In order to compute annual loads for all canyons, estimates of annual flow were made from the hydrographs modeled for Buck Gully and Los Trancos. Flow estimates from this approach are expected to be more representative of typical wet and dry weather flow than using an instantaneous flow measured only at the time of sampling. Flows were predicted for each stream at the mouth based on the respective watershed areas and the modeled flows.

The geometric mean of the yearly predicted flow for both Buck Gully and Los Trancos was calculated for both wet and dry weather flow. The geometric mean was used because the flow data were not normally distributed. The geometric mean was then divided by the total watershed area for both watersheds and that ratio was used in the calculation of dry and wet weather flow at all other watersheds or sub-watersheds by multiplying the ratio and the watershed area. A ratio of 0.000337 cfs/acre was used for dry weather, and for wet weather flows the ratio 0.000934 cfs/acre was used. *Results* Table 3-5 and Table 3-13 present the list of Station IDs and estimated flows. All sites in Buck Gully and sites located at the mouth of canyons were used in this calculation due to the availability of sub-watershed area information.

Dry and wet weather loads for all canyon streams were calculated by multiplying the estimated flow from each site and the constituent concentration sampled from the wet and dry weather events at that site. The same constituents were used as in the calculation of Load Duration Curves. Dry and wet weather loads were assumed to represent <u>hourly loads</u> and determined by multiplying the concentration by the estimated flow and a conversion factor as shown in Equations 3 and 4.

$$\textit{Load (pounds per hour)} = \textit{stream flow (cfs)} \times \mu g/L \times 0.000224 \qquad (3)$$

$$\textit{Load (MPN per hour)} = \textit{stream flow (cfs)} \times MPN/100mL \times 1019406 \qquad (4)$$

An hourly load for both wet and dry weather was calculated at each site by using the median hourly load calculated for the site. As stated above, wet weather data from the Irvine Company for Los Trancos and Muddy Creek were also included. This method was used for any case of multiple sample events. In the case of single sampling events, the hourly load was calculated as stated above.

An estimation of annual loads for wet and dry weather was calculated by multiplying the number of hours within the year of each wet and dry by the median hourly loads estimated for each sample site during wet and dry weather sampling events. The number of hours of wet and dry weather flow was determined from inspection of the predicted flows from the time period of March 15, 2005 through March 15, 2006. Any flow above the baseline was declared wet weather flow until flow returned to 10% of the antecedent. The number of wet weather hours was estimated at 679 and the number of dry weather hours to be 8081. An annual total load for each sample site was estimated as the sum of the dry and wet weather loads.

2.4.2.3 Investigation of Watershed Factors Related to Load

To facilitate further understanding of the loading results, an examination of relationships between watershed characteristics and wet, dry, and total annual loads was performed. Two characteristics were examined: (1) water use by sub-watershed area in the Buck Gully watershed, and (2) residential land use in all watersheds assessed. Water use data from September 2004, City of Newport, was used for the bottom of the watershed and the Irvine Ranch Water District provided water use information for the top of the watershed (Table 2-4). Residential land use for each watershed was calculated using ArcView GIS (Table 2-5). A Pearson Correlation was performed on all constituents for wet, dry, and total annual loads and either the water use or residential land use. If the correlation was above 0.80 then a linear regression analysis was completed to determine significance of the relationship.

Table 2-4. Watershed and Sub-Watershed Areas, Percent Residential Land Use

Station ID	Watershed Area (acres)	Residential Area (acres)
Buck Gully		
BG1	1261.32	742.98
BG2	1152.62	666.33
BG3	1102.29	629.12
BG4	951.47	552.64
BG5	741.34	484.15
BG6	491.80	370.04
BG7	307.18	254.81
Morning Canyon		
MCD	387	209.79
Pelican Point		
PP1	23	9.23
PPM	235	21.56
PPW	143	34.04
Los Trancos		
LTD	1181	401.42
Muddy Canyon		
MCC	996	210.74
El Morro Canyon		
EMD	2143	28.99

Table 2-5. Water use by Sub-Watershed Area.

Site Name (Drainage Area)	Water Usage	Sub-Watershed Area	Cumulative Upstream Area
	(Units)	(Acres)	(Acres)
BG1	21452	108.70	1261.32
BG2	8884	50.33	1152.62
BG3	24171	150.83	1102.29
BG4	10464	210.12	951.47
BG5	10382	249.54	741.34
BG6	8329	184.62	491.80
BG7	18445	307.18	307.18
Grand Total	102128	1261.32	-

3.0 RESULTS

The Newport Coast Flow and Water Quality Assessment was comprised of two dry weather sampling events, three wet weather sampling events, and the Buck Gully Source Investigation. From these investigations, flow was estimated and water quality was analyzed in the freshwater canyon creeks and the ocean mixing zones. The results from this analysis are presented below. Section 3.1 presents the quality control results, ensuring the accuracy and precision of the analytical results. Section 3.2 presents the chemistry and flow results from the dry weather sampling events. Section 3.3 discusses the findings from Todd Engineers' Groundwater Seepage Study with relation to the Newport Coast Flow and WQ Assessment. Section 3.4 presents the results of the Buck Gully Source Investigation. Section 3.5 presents the chemistry, toxicity and flow data from the wet weather sampling events. While the ocean sampling is discussed in its appropriate dry and wet weather sections, the sampling location within the plume is discussed in Section 3.6. Finally, the constituent and flow results are combined and constituent and creek loading is presented in Section 3.7.

3.1 Quality Control

The quality of the chemistry, bacteria, and toxicity results were assessed based on the guidelines of the quality assurance and quality control (QA/QC) programs set forth by CRG Laboratories and Weston's Microbiology and Toxicity laboratories as stated in the *Monitoring Plan and Quality Assurance Project Plan for the Newport Coast Flow and Water Quality Assessment* (Weston 2005). Modifications of the QA/QC guidelines are to be reported in the laboratory analytical report. No QA/QC issues were reported by CRG's or Weston's laboratories. The QC program for the field samples included the collected and analysis of field duplicates and equipment blanks in accordance with SWAMP guidelines as presented in the QAPP. This section presents the results of the field duplicates and field blanks.

Because data was also acquired for Los Trancos and Muddy Creek from the Irvine Company, confidence intervals were created to compare the wet weather sets of data for metals and bacteria. This information is described below.

3.1.1 Field Duplicates

As stated in the *Methods* section, a field duplicate for organophosphate pesticides was collected during each event. In order to assess the quality of the data, the relative percent difference (RPD) was calculated and is presented in Table 3-1. The allowable RPD should generally be less than 20%. During the second wet weather event, the RPD of malathion concentrations is slightly greater than 20%. This may be attributed to the variable nature of storm water runoff in multiple grab samples. The results of the duplicate samples indicate replication of results to be generally within the standards. The results meet the overall QC requirements as stated in the QAPP for field duplicates.

Table 3-1. Relative Percent Difference of Organophosphate Pesticides Field Duplicate Results.

Event	Site	Analyte Detected	Result (ng/L)	Duplicate Result (ng/L)	RPD
1st Dry (09.27.05)	LTU	-	ND	ND	N/A
1st Wet (10.15.05)	BG3	Diazinon	74.5	65.1	13%
		Malathion	204	188	8%
2nd Dry (02.13.06)	BG1	-	ND	ND	N/A
2nd Wet (02.18.06)	BG3	Malathion	133	168	**23%**
3rd Wet (02.27.06)	BG3	Malathion	160	186	15%

3.1.2 Equipment Blanks

In addition, equipment blanks were collected during the second dry weather event on February 13, 2006. The equipment blanks were collected using clean peristaltic tubing through which blank water supplied by the analytical laboratory was run through the automated sampler pump into the sample container. The blank samples were analyzed for total and dissolved metals and organophosphate pesticides. There were no pesticide detections. As presented in Table 3-2 cadmium, copper and zinc were detected in the blank samples at concentrations generally between the method detection limit and the reporting limit.

The EPA defines the method detection limit (MDL) as, "the minimum concentration of a substance that can be measured and reported with 99% confidence that the analyte concentration is greater than zero and is determined from analysis of a sample in a given matrix containing the analyte." The reporting limit (RL) is, "the lowest concentration or amount of the target analyte required to be reported from a data collection project." This limit is not usually associated with a probability level. The results that are between the method detection limit and the reporting limit are shown with a "J" qualifier which represents an estimated result.

The concentrations presented in Table 3-2 that are between the MDL and RL represent less than 10 percent of the total concentrations reported for the collected dry weather and stormwater samples. Although total zinc was detected at a concentration of 1.12 µg/L, this concentration is still less than 10% of the lowest result at the same station for total zinc. The lowest concentration of total zinc detected was during the first dry weather event with a result of 19.1 µg/L. The blank result is less than 6% of the dry weather results. In addition, zinc was not observed at concentrations greater than the water quality objectives in either wet or dry samples. The source of the metals detected in the equipment blank are likely from the automated sampler pump. The inside mechanical components of the pump can not be readily decontaminated between sampling events. Because these metals concentrations detected in the equipment blank sample represent less than 10 percent of the total concentrations, and are well below the WQO, the results used for this assessment are representative and do not need to be qualified for blank contamination.

Table 3-2. Equipment Blank Results from Select Metals.

		Result (µg/L)	MDL (µg/L)	RL (µg/L)
Cadmium	Total	J0.18	0.1	0.2
	Dissolved	0.24	0.1	0.2
Copper	Total	J0.13	0.1	0.5
	Dissolved	J0.31	0.1	0.5
Zinc	Total	1.12	0.1	0.5
	Dissolved	J0.15	0.1	0.5

"J" value denotes an estimated value between the method detection limit (MDL) and reporting limit (RL).

3.1.3 Confidence Intervals for Irvine Company Data

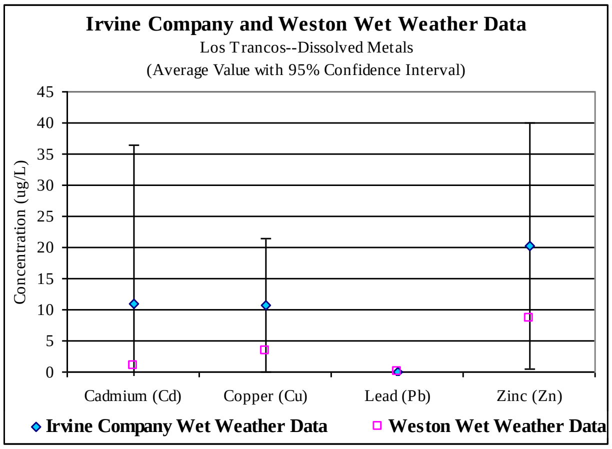
As discussed in Section 2.4.2.1, all Weston dissolved and total metals concentrations, for the constituents of interest, fell within the confidence bounds of the Irvine Company data (Figure 3-1). Weston's bacterial results at Los Trancos and Muddy Creek were higher for the sampling event than concentrations collected by the Irvine Company, falling above the 95% confidence bound. Therefore, Irvine Company wet weather dissolved and total metals data were used only for metals wet weather load estimates at Muddy Creek and Los Trancos, and not for bacterial load calculations. Weston data (one sample) were used to calculate wet weather bacterial loads at Muddy Creek and Los Trancos.

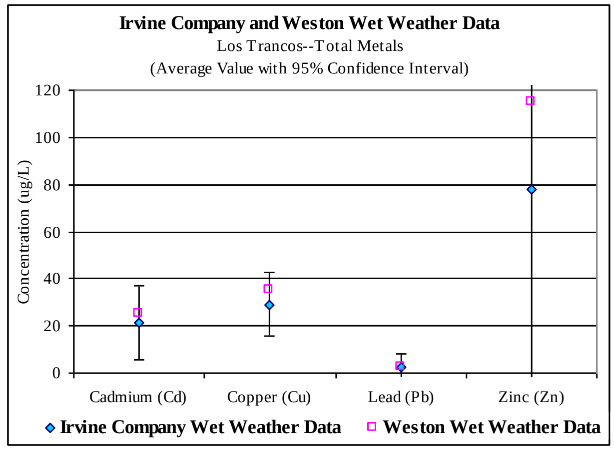
3.2 Dry Weather

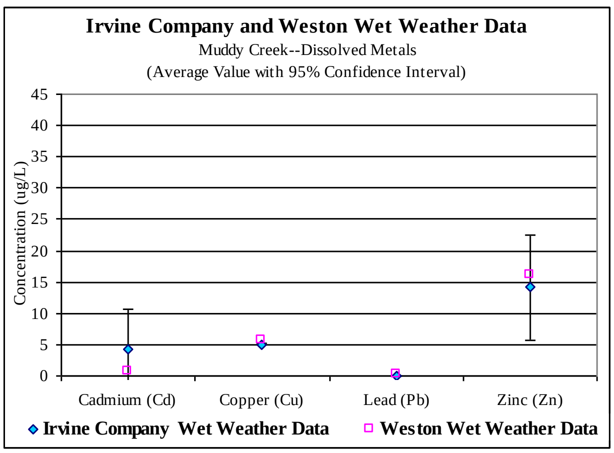
In accordance with the QAPP two dry weather sampling events were conducted to obtain samples representative of a summer dry and winter dry condition in the coastal canyons. Figure 3-2 presents the dry weather sampling locations. The first 24-hour dry weather sampling event began at 8:00pm on September 27, 2005, which represented a summer dry condition. The composite samples were collected at BG1 and EMD using automated flow and sampling equipment collecting flow-weighted samples for the duration of the event. The ocean samples (BGO and EMO) were collected every three hours and composited evenly at the end of the event. Grab samples and flow from the other sites were collected on September 28th during peak daily flow between 8:00am and 2:00pm. The second, modified dry weather event occurred on February 13, 2006, which represented the winter dry condition. Grab samples were collect at four sites in Buck Gully and two sites in El Morro between 11:30am and 5:00pm (Figure 3-2).

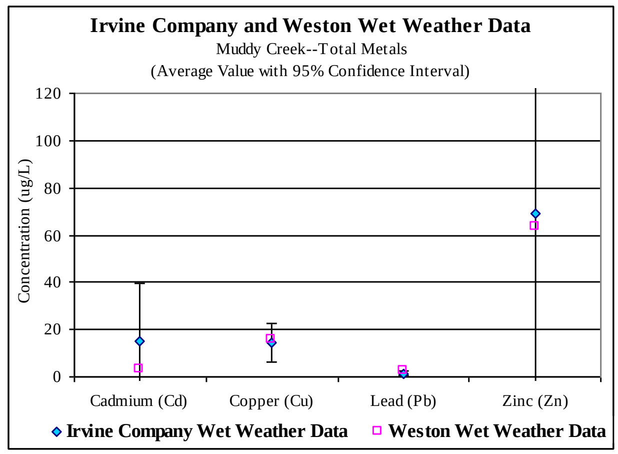
3.2.1 Chemistry

As presented in Table 2-3 (*Methods* section), the composited samples from the first dry weather event were analyzed for the full list of Ocean Plan constituents. The other sites during the first dry weather event and all of the sites sampled during the second dry weather event were analyzed for the focused list of constituents. The analytical reports are located in Appendix C; the Microbiology reports are located in Appendix D.









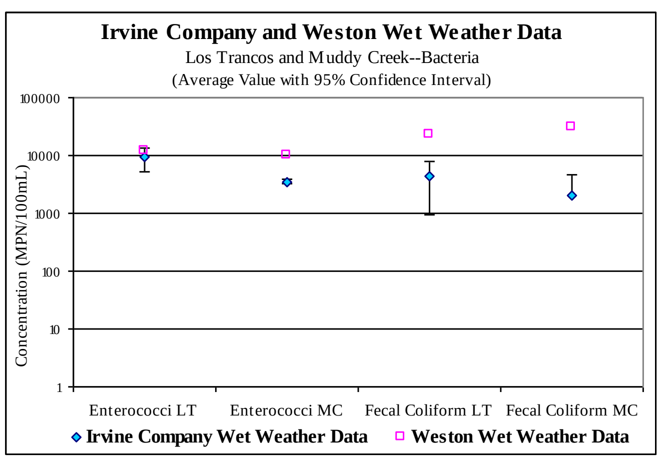


Figure 3-1. Irvine Company Weston Confidence Interval.

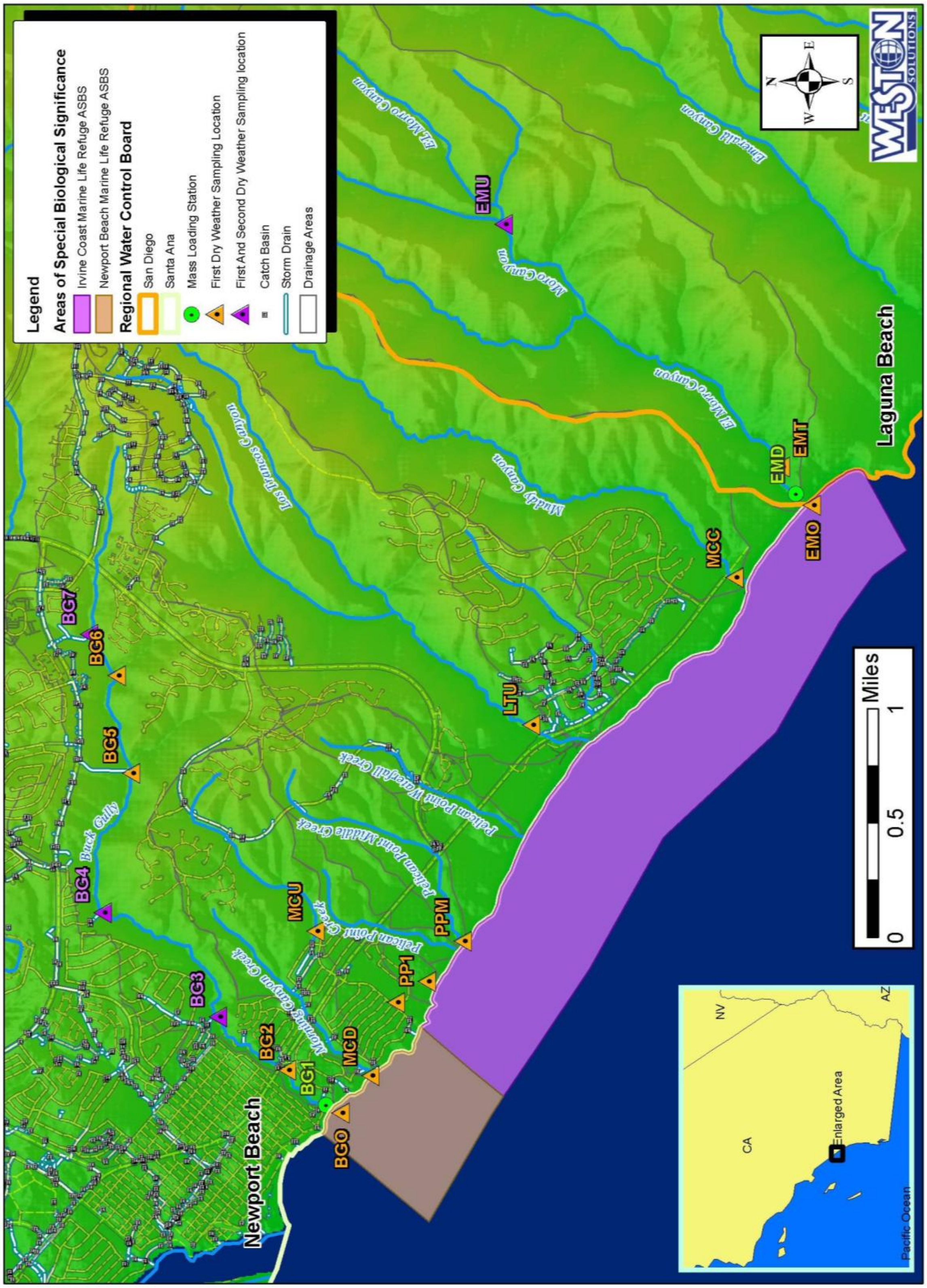


Figure 3-2. Dry weather sampling locations.

Table 3-3 presents a summary of the cadmium, copper, and bacterial results for the September and February dry weather events. Cadmium and bacteria exceeded the WQOs. Dry weather dissolved metals concentrations detected in the freshwater canyon creeks are compared to the California Toxic's Rule (CTR), which lists hardness-based WQOs for the total and dissolved recoverable forms of arsenic, cadmium, chromium III, copper, lead, mercury, nickel, silver, and zinc. As highlighted in bold in Table 3-1, the dissolved cadmium concentrations exceeded the CTR at the Buck Gully (BG1), Downstream Morning Canyon (MCD) and Pelican Point Middle Creek (PPM). The exceedance at Buck Gully occurred in February; whereas the exceedances at MCD and PPM were observed in the September sampling event. There was also an exceedance at the Pelican Point Middle Creek (PPM) for dissolved copper for the September sampling event. PPM was not sampled during the second February dry weather event.

Figure 3-3 presents the dissolved cadmium results across the watersheds. As shown in the figure, Pelican Point Middle Creek and Morning Canyon Downstream exceeded the CTR WQO for CCC of 6.22 µg/L for the grab samples collected in the September event. The Buck Gully composite mass loading station sample in September did not exceed the WQO, but was slightly above the criteria in the samples collected during the second February dry event. As evidenced in the figure, the concentration of dissolved cadmium at PPM was over an order of magnitude greater than at Buck Gully.

Figure 3-4 presents the dissolved cadmium levels for the Buck Gully downstream and upstream sample locations. During the first dry event in September that represented summer conditions, the concentrations were highest at BG4 located in the middle section of Buck Gully downstream of the Spyglass Ridge Community. During the second dry event in February, the concentrations were highest at the downstream site and gradually decreased upstream. Concentrations were generally greater in the second dry weather sampling event.

Within the Newport coastal canyon watersheds, it can be reasonably assumed that the vast majority of metals contributed to the canyon creeks and ocean are from non-point sources. There are no direct discharges from wastewater treatment plants or groundwater treatment facilities within these watersheds. Potential non-point sources of heavy metals in urban runoff based on a study conducted in Santa Clara California concluded that urban runoff from roads was the largest contributor (Woodward-Clyde 1998). The metals from roadway runoff included cadmium (tires), copper (brakes and tires), lead (brakes, tires, fuels and oils) and zinc (tires, brakes, auto frame). Secondary contributions were cited to include contaminated sediments, atmospheric depositions and miscellaneous sources, such as antifouling paints from boats. All these non-point sources of heavy metals including cadmium and copper exist in the Newport coastal canyon watersheds.

Table 3-3. Newport Coast Dry Weather Exceedances.

Constituent		Copper Dissolved	Copper Total	Cadmium Dissolved	Cadmium Total	Total Coliforms	Fecal Coliforms	Enterococcus
Units		µg/L	µg/L	µg/L	µg/L	MPN/100mL	MPN/100mL	MPN/100mL
WQO		**29.28**	**12** / **30.5**	**6.22**	**4** / **7.31**	**10,000**	**400**	**105**
WQO Source		CTR CCC[1] (Hardness > 400)	Ocean Plan Daily Max / CTR CCC[1] (Hardness > 400)	CTR CCC[1] (Hardness>400)	Ocean Plan Daily Max / CTR CCC[1] (Hardness>400)	Ocean Plan[2]	Ocean Plan[2]/ Basin Plan[3]	Ocean Plan[2]
BGO	**(9.27.05)**	0.754	2.85	<0.005	**4.58**	300	<20	**228**
BG1	**(9.27.05)**	9.06	1.09	1.12	3.36	3000	230	213
	(2.13.06)	11.1	11	**6.39**	**9.01**	170	40	121
EMO	**(9.27.05)**	0.475	1.54	<0.005	0.045	<20	<20	<10
EMD	**(9.27.05)**	5.26	0.199	0.87	1.48	500	300	<10
	(2.13.06)	6.08	5.64	2.67	3.34	500	40	30
BG2	**(9.27.05)**	8.91	9.52	2.07	3.58	5000	210	327
BG3	**(9.27.05)**	8.5	9.48	2.13	3.92	1700	220	121
	(2.13.06)	11	11.4	**6.23**	**7.96**	500	40	52
BG4	**(9.27.05)**	7.75	7.47	2.52	5.47	800	130	52
	(2.13.06)	9.4	10.5	4.85	**8.01**	220	20	20
BG5	**(9.27.05)**	3.97	5.69	0.95	0.96	500	40	20
BG6	**(9.27.05)**	2.09	3.41	0.48	0.34	1700	300	63
BG7	**(9.27.05)**	2.9	3.62	0.51	0.61	800	130	84
	(2.13.06)	5.14	3.59	3.04	3.35	170	70	63
MCD	**(9.27.05)**	15	17.2	**26.2**	**36.7**	2300	40	480
MCU	**(9.27.05)**	6.7	7.6	2.26	2.44	1700	300	279
PP1	**(9.27.05)**	6.55	9.58	2.82	3.75	30000	**1400**	798
PPM	**(9.27.05)**	**35.1**	12.8	**100**	**105**	270	<20	73
LTU	**(9.27.05)**	10.3	11.8	3.51	**12.3**	3000	**2300**	613
MCC	**(9.27.05)**	7.16	5.88	1.11	1.34	5000	**800**	132

[1] CTR CCC = The California Toxic's Rule Criterion Continuous Concentration (chronic criterion) defined as a four-day average concentration limit (EPA 65 FR 31682).

[2] The Ocean Plan WQOs for total coliforms, fecal coliforms, and Enterococcus are single sample objectives for samples collected in the ocean and do not apply to freshwater samples.

[3] The Basin Plan WQO for fecal coliforms states, "the log mean [must be] less than 200MPN/100mL based on five or more samples/30 day period, and not more than 10% of the samples exceed 400 MPN/100mL for any 30-day period." Therefore, as a conservative approach, the WQO presented here assumes that one samples would equal 10% of the monthly samples, and a result greater than 400MPN/100mL would exceed the WQO.

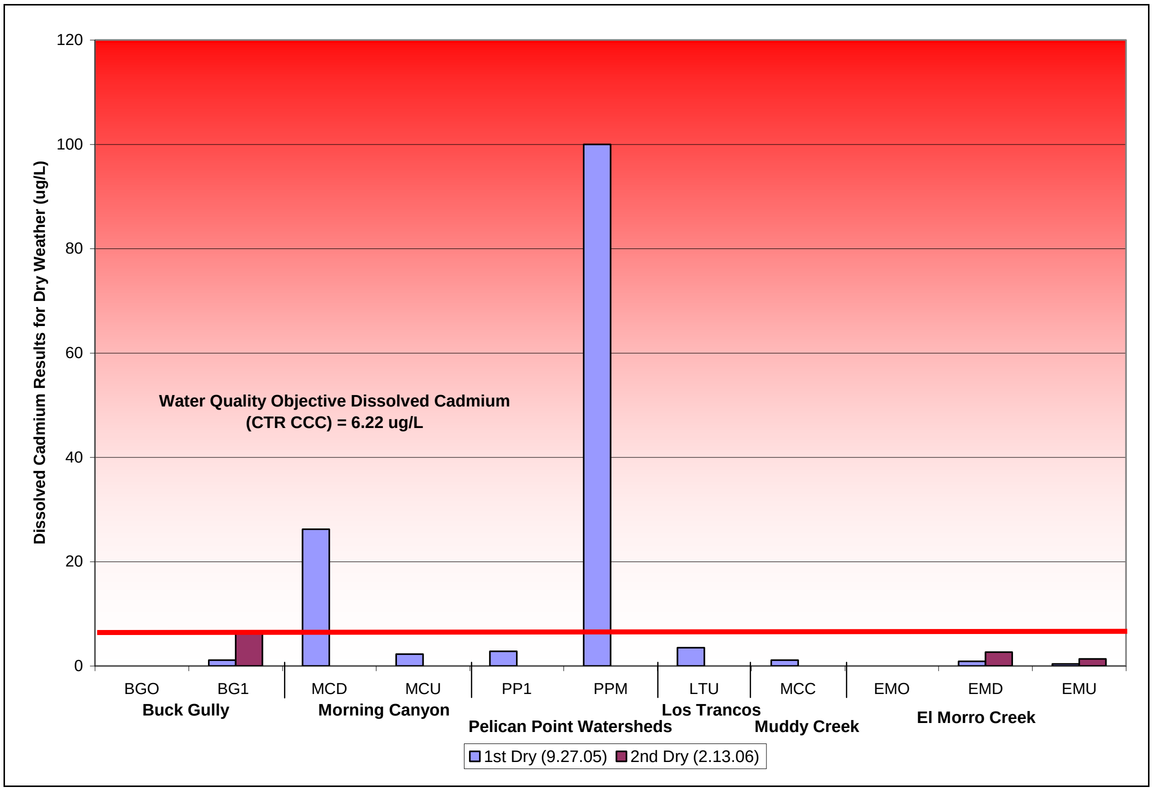


Figure 3-3. Dissolved cadmium results during dry weather sampling in the Newport Coast Watersheds.

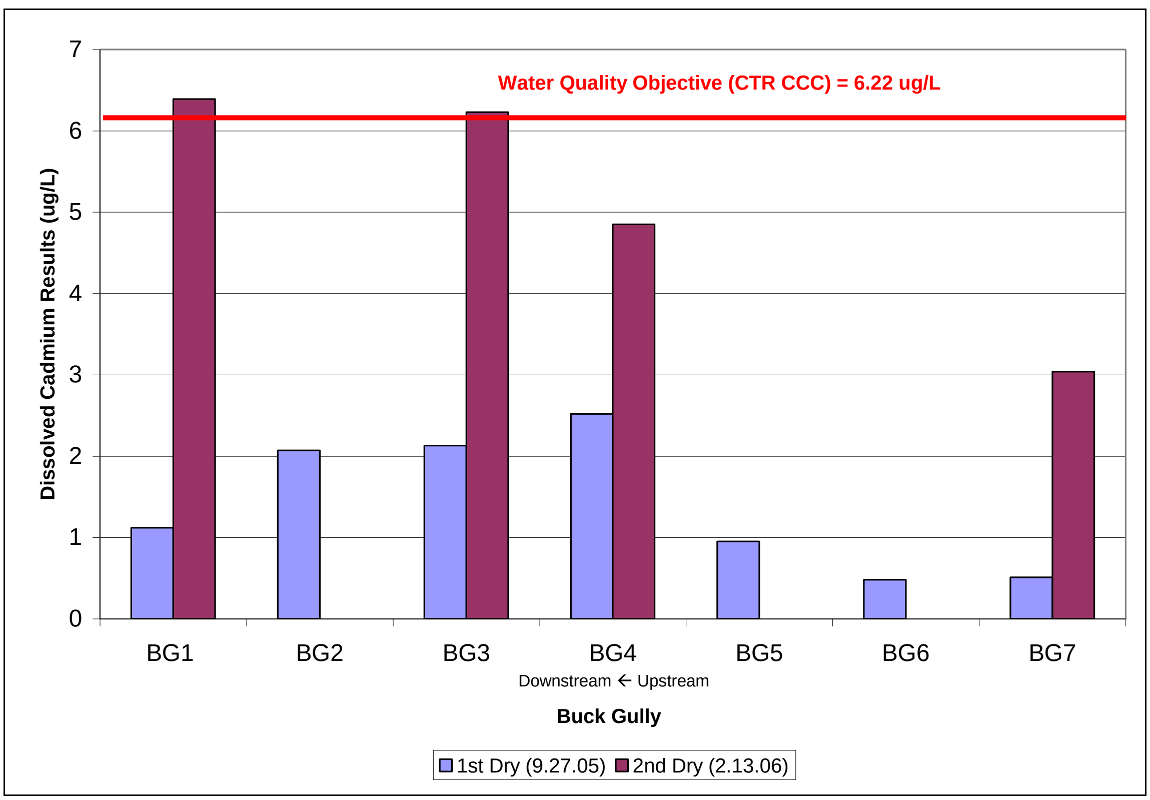


Figure 3-4. Dissolved cadmium results during dry weather sampling in Buck Gully.

In additions to these predominate sources; cadmium is also found in some fertilizer, primarily phosphate fertilizers (OECD 1994, ERL 1990), and from composts applied to plants and grasses (Ingram 2006). The EPA also states that cadmium salts have had a very limited use as a fungicide for golf courses and home lawns (EPA 2006b). It is not known the type of fertilizer or if compost is used by the golf courses that are located within the Buck Gully, Morning and Pelican Point watersheds. Metal roofing has also been identifies as a source of cadmium (Van Metre & Mahler 2003). Cadmium also occurs naturally in zinc, lead, and copper ores.

Additional sources of copper in water include corrosion of copper pipes in the interior of residences and other buildings. Possible natural sources of metals are forest fires, decaying vegetation, and sea spray (Lenntech 2006).

The revised 2005 California Ocean Plan added single sample bacterial maximum criterion. The total coliform maximum criterion of 10,000 MPN/100mL was not exceeded at either ocean site. While this WQO is not applicable to the freshwater samples, it is noted that the PP1 result (Table 3-3) does exceed this criterion. The Ocean Plan WQOs for fecal coliforms and Enterococci are the same as AB411 freshwater standards commonly used throughout the state as beach closure guidelines. The ocean sample in the mixing zones of Buck Gully and the corresponding freshwater sample at the mouth of Buck Gully exceeded the saltwater WQO for Enterococcus. Similarly, the Ocean Plan WQO for Enterococcus does not apply to the freshwater samples, but is listed as a reference. Only fecal coliforms have a corresponding freshwater WQO (400 MPN/100mL). There were no exceedances of fecal coliforms in Buck Gully, Morning Canyon, or El Morro Creek for either dry event. There were exceedances of fecal coliforms in the northern most Pelican Point watershed (PP1), Los Trancos, and Muddy Creeks.

Table 3-4 present the gross alpha and beta particle results as well as the total dioxin results for the first dry weather event in Buck Gully and El Morro. The analyses of the radiation samples at the mass loading stations at Buck Gully and El Morro for gross alpha and beta indicated an exceedance of the Basin Plan objective for gross alpha of 15 pCi/L at both of these locations. The corresponding ocean site, BGO, was not sampled for this analyte. Radiation is naturally occurring in the environment in nearly all rocks, soils, and water. Alpha particles are given off by uranium and radon in addition to other processes of decay activity. The results further indicate that the concentrations reported for Buck Gully may be natural sources as the gross alpha concentrations are near the reported error limits of the reference site (El Morro).

Table 3-4. Gross Alpha and Beta and Total TCDD Equivalent Results form the First Dry Weather Event.

	WQO	WQO Source	Buck Gully MLS (BG1)	El Morro MLS (EMD)
Gross Alpha (pCi/L)	15	Basin Plan	**23.2 ± 3.39**	**16.8 ± 2.69**
Gross Beta (pCi/L)	50	Basin Plan	7.2 ± 6.79	0 ± 6.1
Total TCDD Equivalents (pg/L)	0.0039	Ocean Plan 30-Day Average	0.6039	0

Dioxins were analyzed at the mass loading stations at Buck Gully (BG1) and the reference site (El Morro) during the first dry weather event. They were detected at BG1. However, the Basin Plan does not have a WQO for dioxins. The total dioxin result presented in Table 3-4 is based on a calculation provided by the Ocean Plan. The Ocean Plan defines TCDD Equivalents as, "the sum of the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors." While not a WQO for freshwater, the TCDD Equivalents' result at BG1 was above the Ocean Plan objective of 0.0039 pg/L. Dioxin is not produced or used commercially in the United States. The EPA states that the release patterns of dioxin include, "stack emissions from the incineration of municipal refuse and certain chemical wastes, exhaust from automobiles powered by leaded gasoline, emissions from wood burning in the presence of chlorine, accidental fires involving transformers containing PCBs and chlorinated benzenes, and from the improper disposal of certain chlorinated chemical wastes (EPA 2006c)." In addition, dioxins may be generated naturally from forest fires.

3.2.2 Flow

Estimates of dry weather flows are presented in Table 3-5. No flows from LTD or MCC were calculated due to dry weather diversions at those sites. These flows were estimated based on the annual hydrograph as described in Subsection 2.3.2.3. Flows were predicted for each stream at the mouth based on the respective watershed areas and the modeled mean annual runoff rates during dry periods. Because the flow at each site is based on watershed area, flows at El Morro (EMD) are relatively high at 0.72 cfs while flows at PP1 are low at 0.01 cfs. Instantaneous flows measured were not well correlated to the estimated dry weather flows. The flow estimates were used for loading calculation since they are expected to be more representative of mean dry weather flows than using an instantaneous flow measured only at the time of sampling.

Table 3-5. Dry weather flows per unit area

Station ID	Unit Modeled Flow (cfs)
Buck Gully	
BG1	0.43
BG2	0.39
BG3	0.37
BG4	0.32
BG5	0.25
BG6	0.17
BG7	0.10
Morning Canyon	
MCD	0.13
Pelican Point	
PP1	0.01
PPM	0.08
PPW	DRY
Los Trancos Canyon	
LTD*	
Muddy Canyon	
MCC*	
El Morro Canyon	
EMD	0.72

*Dry weather flows are diverted at these sites

3.3 Groundwater Seepage Study

The City of Newport Beach is conducting an investigation of groundwater seepage observed along portions of the Newport Coast. Todd Engineering has been contracted by the City of Newport Beach to complete this study to assess the magnitude of the seepage, evaluate its sources, and identify monitoring and mitigation measures. Preliminary findings have been presented in the Draft Newport Coast Seepage Study (Todd 2006). These preliminary findings are summarized in this section.

Groundwater seepage into the coastal canyons is a component of the flows that have been investigated as part of the Water Quality and Flow Assessment. The source of groundwater seepage includes infiltration from direct precipitation and from imported water sources used for irrigation of residential and commercial landscaping. Depending on the component of seepage into the coastal canyons, these flows can represent a significant portion of the dry weather flows observed in these receiving waters. The other component of the dry weather flows is direct urban runoff. The Water Quality and Flow Assessment has included measurement of the dry weather flows, collected samples for water quality evaluation and investigated sources of direct discharges into the creeks during dry weather conditions. Important to this assessment is understanding the overall sources of dry weather flows of which the groundwater seepage component is likely a significant portion.

The Groundwater Seepage Study included a water balance analysis under pre- and post-development conditions for the Buck Gully, Morning Canyon and Pelican Point watersheds. The analysis concluded that due to an increase in impervious surfaces from development, groundwater seepage from infiltration of direct precipitation has decreased by an estimated 25 percent for these contiguous watersheds. However, overall potential groundwater seepage is estimated to have increased by approximately 300 percent from 66 acre-feet per year (AFY) to 269 AFY due to a significant increase in the recharge from water import into these watersheds. This significant increase in recharge has altered the hydrogeological conditions within these watersheds.

Based on published geological information on the coastal watersheds (no subsurface investigations were conducted as part of the groundwater study), the Newport coast geology is characterized by consolidated sandstone, shales, and volcanic rocks which are overlain along the coastline by terrace deposits, and along the deeper costal canyon creeks by thin and narrow alluvial deposits. Direct precipitation and irrigation waters infiltrate through regraded, natural or deposited local soils and flow under unconfined conditions through these formations. Groundwater daylights as seepage at lower elevations in deep canyon cuts and at the coast. Regional groundwater elevation data is not available; however, historical records indicate very low production and likely variable levels due to low precipitation rates and steep gradients. The highest groundwater levels have been observed in the canyon alluvial deposits.

Increased recharge from imported water irrigation is suspected to have created a groundwater mounding effect toward the lower portions of the coastal canyons evaluated as part of the Groundwater Seepage Study. Greater groundwater seepage flows have been recorded by Todd Engineering at the mouth of Buck Gully, which is consistent with Weston's flow measurement at

Little Corona Beach. The generalized groundwater model for the developed coastal canyons consists of recharge from precipitation and more significantly from imported water used for irrigation that infiltrates down into the geologic formations through an unsaturated flow regime to an unconfined groundwater table that likely has a steep gradient toward the coast. Groundwater seepage occurs where deeper canyon creeks such as Buck Gully and Los Trancos cut down to an elevation that intersects with the groundwater table and where perched groundwater is present in the creek alluvial deposits. Farther down the canyons toward the coast, a groundwater mound has developed from the additional recharge which results in additional groundwater seepage due to the rise in groundwater levels.

This generalized model suggests that dry weather flows within the developed canyons consist predominantly of groundwater seepage from the infiltration of irrigation waters that have been imported to the Newport Coast. This model is supported by the observations and measurements of flows during the dry weather source identification tasks for Buck Gully. The findings of this investigation indicated that dry weather urban runoff flows from storm drains were not a large portion of the flow observed in the creek during peak flows. The findings also suggested a large groundwater seepage component. Increased infiltration has resulted in a groundwater mound that may be the source of increased dry weather flow between the middle and lower portion of Buck Gully. Weston reported an increase of 0.3 cfs between Coast Highway and the mouth of the creek at Little Corona Beach.

This model also suggests that the quality of the dry weather flows is significantly influenced by the quality of the infiltration waters and the groundwater seeps. Analysis of groundwater seeps by Todd Engineering for chloride and sulfate indicated higher concentrations of these constituents downgradient of potential sources compared to upstream samples. The Draft Groundwater Seepage Report indicated that the golf course at Pelican Point may increase concentrations of these constituents through the use of soil amendments and provide a migration pathway through irrigation. Oxygen – Deuterium Isotope analysis conducted by Todd Engineering to assess the potential source of the groundwater seepage, indicated that the seeps sampled were more characteristic of the treated irrigation water than local precipitation. The conclusion from these results confirms the hydrological estimates of seepage contributions predominantly from imported waters that are used for irrigation that infiltrate and daylight as groundwater seeps in the lower portions of the canyon creeks.

Post-Development groundwater seepage in Buck Gully from both precipitation and irrigation infiltration was estimated to be 107 acre-feet/year by Todd Engineers. The total volume of water derived from the modeled hydrograph at Buck Gully (Section 2.3.2.3) is 240 acre-feet/year. This estimated dry weather flow is based on the modeled mean flow for Buck Gully of 0.36 cfs multiplied by the estimated hours of dry weather of 8081 hours. The difference between the modeled base flow and groundwater seepage cannot be attributed to direct dry weather urban runoff as this was not substantiated by observations and measurements made during the dry weather source identification investigation. It is more likely that the difference stems from the conservative assumptions made in the groundwater seepage estimates. For example, pipeline water leaks estimated at 3% may be to low.

3.4 Buck Gully Dry Weather Source Investigation

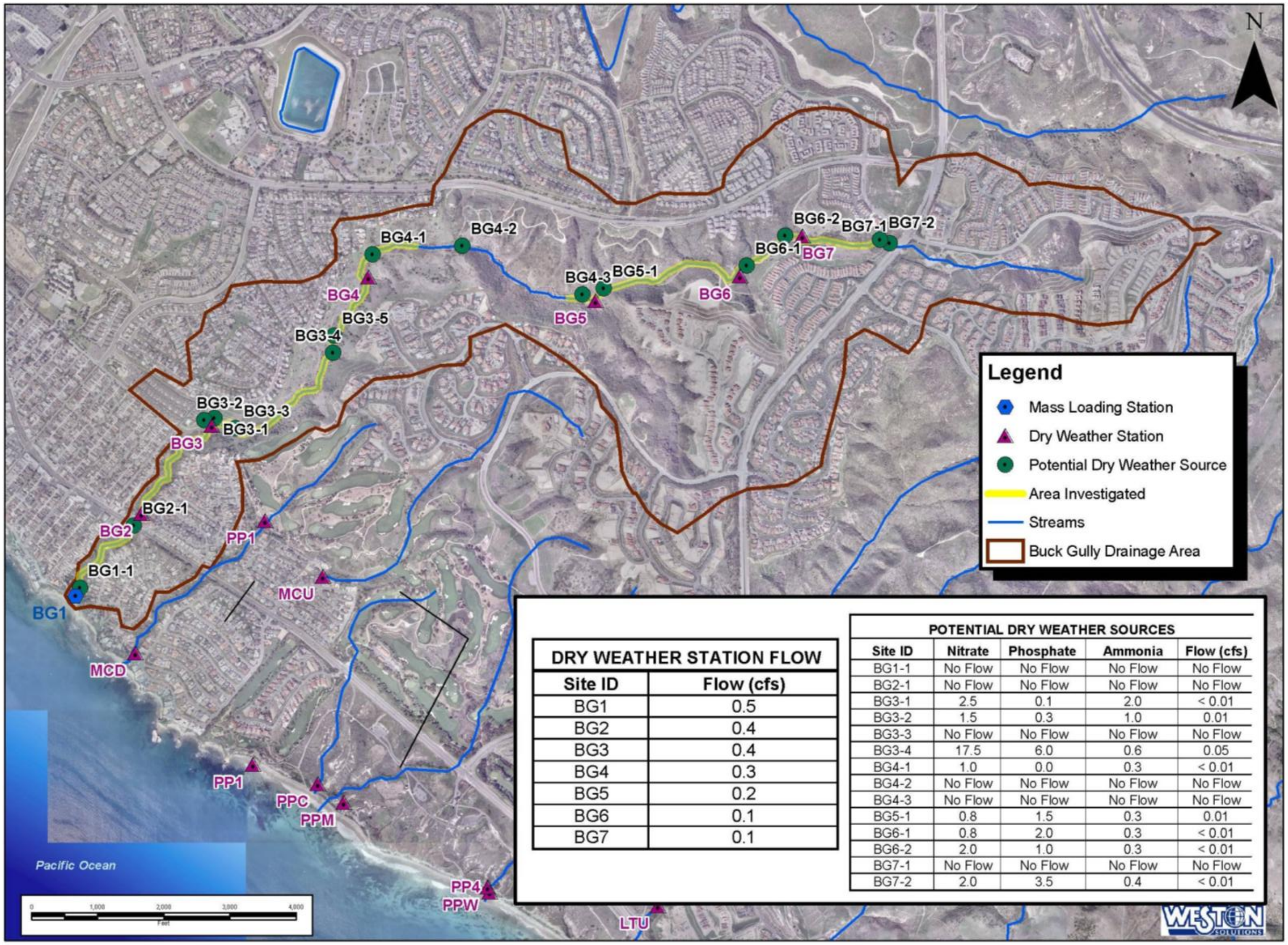
After analyzing the preliminary result of the first dry weather sampling event from September 27th and 28th, 2006, an investigation of Buck Gully's dry weather sources began on November 16, 2005. The goal of this investigation was to identify potential sources of dry weather flow into Buck Gully, as well as to measure instream and stormdrain/drainage channel flows throughout the canyon to identify sources within the canyon that had greater flow contributions. Potential sources of dry weather flows were suspected to include direct urban runoff from irrigation, car washing, and other residential activities that are captured in the municipal storm drain system and discharged to the creek through storm drain outlets.

Three teams were sent out to sample the full length of Buck Gully, presented in Figure 3-5. To capture the peak flow seen during the first dry weather event between 9:00am and 11:00am, the investigation began at approximately 8:00am. Due to the steep terrain and the associated safety issues of accessing and walking the stream, the investigation took longer than expected and lasted until sunset on November 16, 2005 and was then continued the next day.

The Buck Gully Dry Weather Source Investigation provided preliminary flow and water quality data for Buck Gully and its dry weather sources. In verifying the flow data in the stream, it appears that two segments have increasing flow: (1) between Little Corona Beach and the Coast Highway (BG1 and BG2), and (2) the large section between Poppy Lane (BG3) and BG6. General water quality measurements taken in the stream did not exceed water quality objectives.

Fourteen potential sources of dry weather flows were investigated in Buck Gully based on reconnaissance surveys conducted during the first dry weather sampling event and follow-up focused surveys of specific storm drain outfalls. Maps of the municipal storm drain system were first obtained from the City and the locations verified during the reconnaissance surveys. Seven of these sources had water flowing through them at the time of the investigation. Three of these sources were observed to have measurable flows. One of these sources was identified to contain nitrate and phosphate levels at least five times higher than the other sites tested. Figure 3-5 presents the potential dry weather flow sources investigated during the Buck Gully Source Investigation.

The largest relative flow was found in a tributary between BG3 and BG4 in an open channel. This flow was also the source with the highest nitrate and phosphate values. **Error! Reference source not found.** presents the water use data for Buck Gully along with the drainage area for BG3-4. The residences within this subdrainage area in the Pelican Hill Community have higher water consumption than the communities to the north. Another source found in the section between BG3 and BG4 is at the catchment basin at Poppy Lane and 5th Avenue. Inside the locked fence, a four inch PVC pipe is attached to the inside of the larger 48 inch RCP and was continuously discharging water. The water quality results here are lower for nitrate and phosphate, but have the highest ammonia value of 2.0 ppm. The third source is just upstream of BG5 and is a tributary entering the channel from the southeast bank. This flow has been observed as a continuous flow since the first dry weather event. However, during a visit on November 21, 2005, the flow had ceased.



DRY WEATHER STATION FLOW	
Site ID	Flow (cfs)
BG1	0.5
BG2	0.4
BG3	0.4
BG4	0.3
BG5	0.2
BG6	0.1
BG7	0.1

POTENTIAL DRY WEATHER SOURCES

Site ID	Nitrate	Phosphate	Ammonia	Flow (cfs)
BG1-1	No Flow	No Flow	No Flow	No Flow
BG2-1	No Flow	No Flow	No Flow	No Flow
BG3-1	2.5	0.1	2.0	< 0.01
BG3-2	1.5	0.3	1.0	0.01
BG3-3	No Flow	No Flow	No Flow	No Flow
BG3-4	17.5	6.0	0.6	0.05
BG4-1	1.0	0.0	0.3	< 0.01
BG4-2	No Flow	No Flow	No Flow	No Flow
BG4-3	No Flow	No Flow	No Flow	No Flow
BG5-1	0.8	1.5	0.3	0.01
BG6-1	0.8	2.0	0.3	< 0.01
BG6-2	2.0	1.0	0.3	< 0.01
BG7-1	No Flow	No Flow	No Flow	No Flow
BG7-2	2.0	3.5	0.4	< 0.01

Figure 3-5. Potential dry weather sources identified in the Buck Gully drainage area

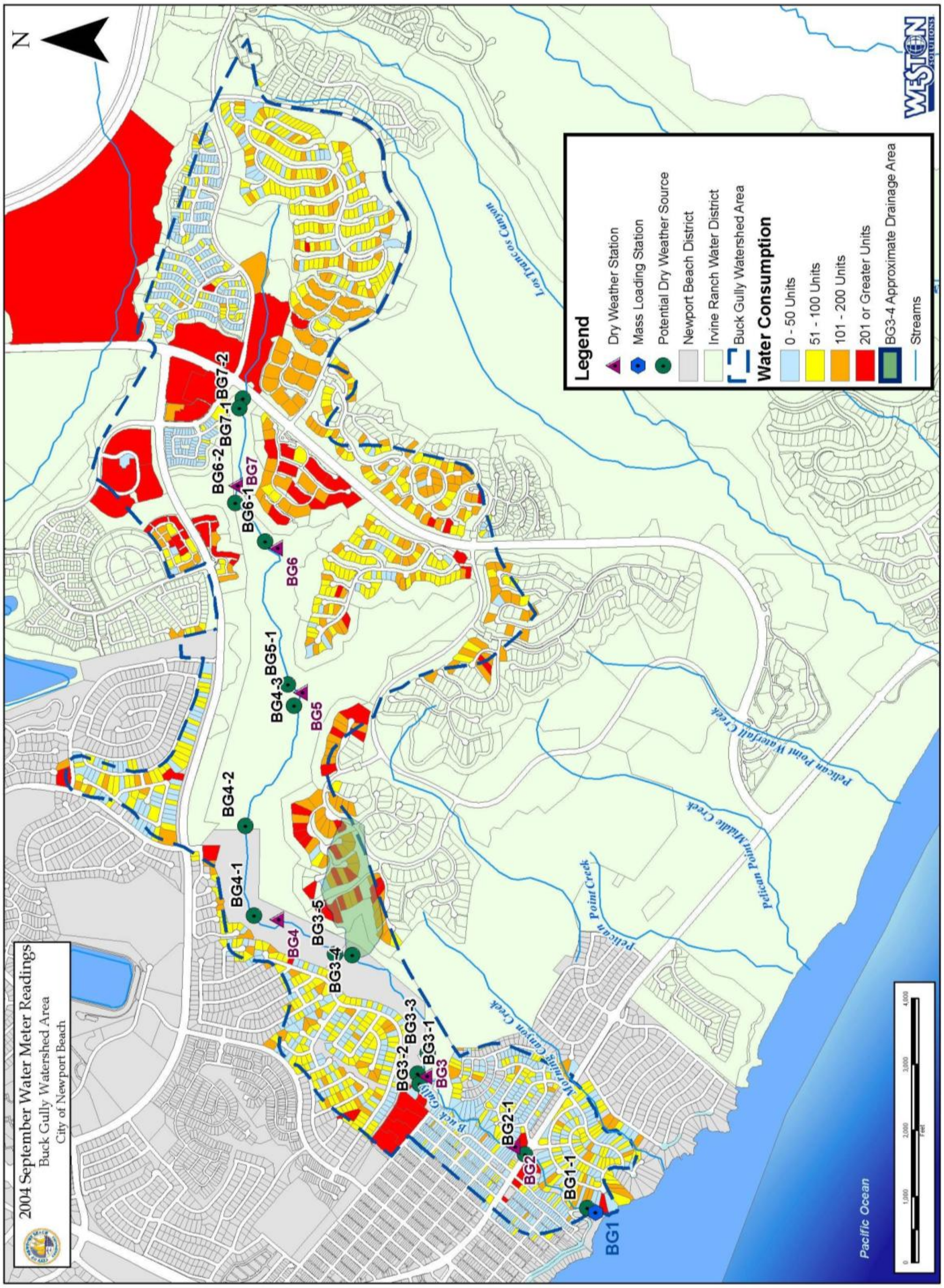


Figure 3-6. Buck Gully potential dry weather sources and water use.

Based on previous flow data reported by Rivertech and measurements of dry weather flow at the MLS at the mouth of Buck Gully, dry weather flow peaks between 9:00 and 11:00am. Based on this available data, the source identification survey was initiated at 8:00am. The actual observations of flow at the storm drain outlets and open channels that discharge into Buck Gully Creek indicate that direct flow from these potential sources is minimal and does not correspond to the total flow trends observed in the creek. The combined dry weather flows from the sources identified do not constitute the total flow measured in the channel, and therefore are not the only sources of increased flow in the stream as it flows to Little Corona Beach. As discussed in Section 3.3, groundwater seepage is likely the additional potential source of flow into the channel. The source of the groundwater seepage is predominately from the use of imported water for irrigation that infiltrates into the ground and discharges to the creek as seepage rather than direct urban runoff. Greater direct flow from urban runoff may be observed in the storm drain system outlets during irrigation activities in the evening, but they do not constitute the source of the higher flows observed in the creek during the morning hours.

3.5 Wet Weather

Three storm events were monitored during the 2005/2006 wet weather season. Figure 3-7 presents the wet weather station locations. The first wet weather event was monitored for a duration of nine hours over the night of October 16th and 17th, 2005. Rainfall for the event sampled totaled 0.46 inches. The MLS and ocean mixing zone sites were sampled for the full list of constituents. The samples collected from the remaining sites were monitored for the focused list of constituents. The remaining two wet weather events took place overnight on February 18th and 19th and February 27th and 28th, 2006. The samples collected at these sites were analyzed for the focused list of constituents. In addition, during the second wet weather event, the Buck Gully ocean mixing zone site was sampled and analyzed for acute and chronic toxicity, residual chlorine and TSS. The rainfall totals for the first event in February of 2006 were 0.11 inches. As a follow-up, the mass loading station on Buck Gully, BG1, was sampled during the third wet weather event for acute toxicity. The rainfall totals for the third event were 0.66 inches. The analytical and flow results are discussed below.

3.5.1 Chemistry

Chemistry samples from the three wet weather events were analyzed by CRG Laboratories. The first wet weather event provided chemistry results for the ocean and freshwater sites. Table 3-6 presents select results, exceedances of the WQOs at the ocean mixing zone, and corresponding mass loading stations from the first storm event.

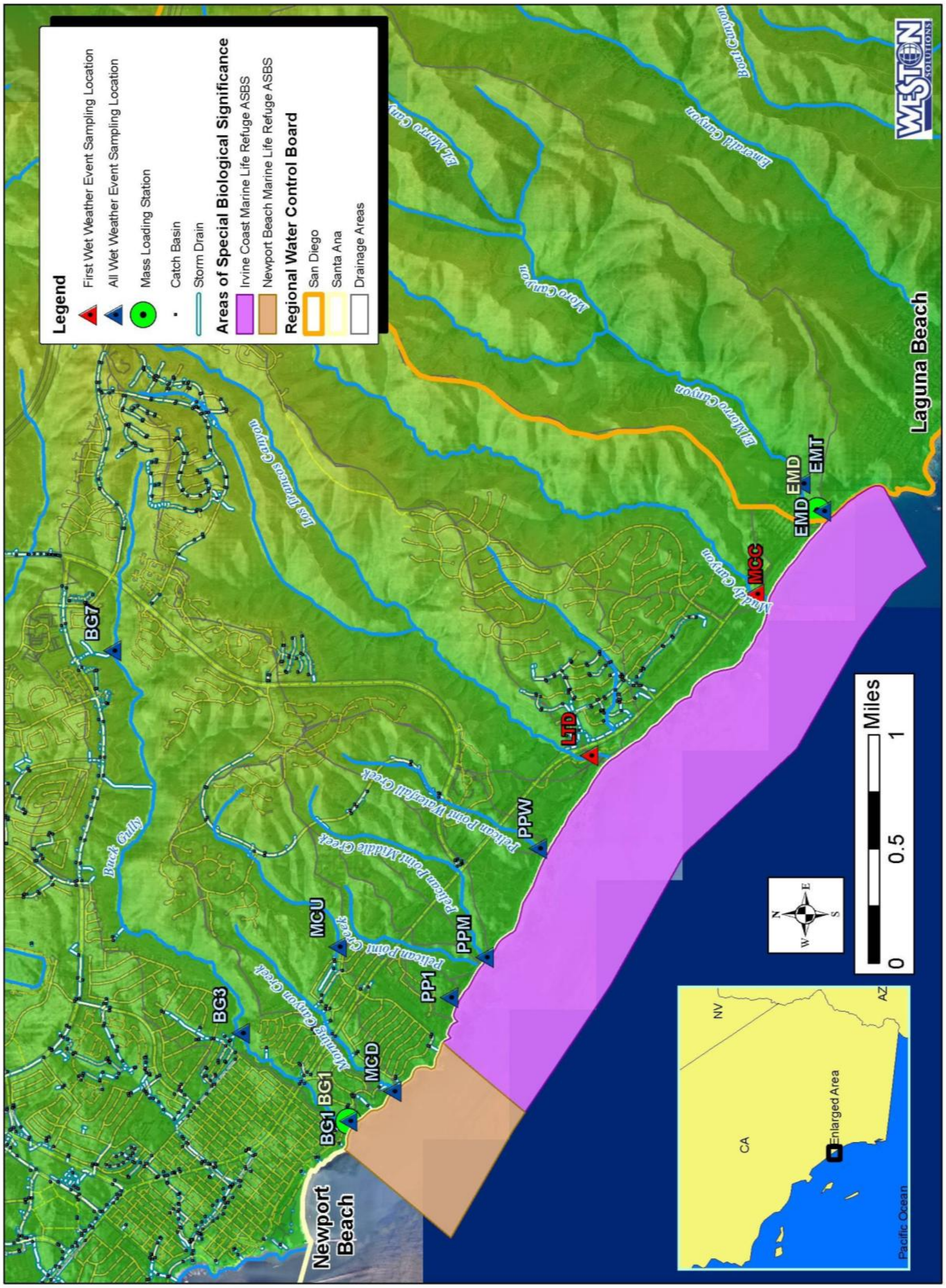


Figure 3-7. Wet weather sampling locations.

Table 3-6. Select analytical results for the MLS and ocean mixing zones during the first wet weather event.

Constituent	BGO	BG1	EMO	EMD
Hardness as CaCO3 (mg/L)	972	1660	5150	1270
TSS (mg/L)	**144**	200	**36.5**	41.7
SS (mg/L)	<0.2	<0.2	<0.2	<0.2
Residual Chlorine (mg/L)	**0.18**	**0.21**	<0.01	**0.21**
Total Ocean Plan PAHs[1] (µg/L)	0.1335	0.1385	0.3166	0.3213
TCDD Equivalents (pg/L)	N/A	2.62	N/A	1.43
1,4-Dichlorobenzene (ng/L)	<10	93.5	<10	62.6

\# Numbers bold and in red have exceeded a water quality objective as stated in the approved Newport Coast Flow and Water Quality QAPP.

1 Total PAHs as defined in the Ocean Plan are acenaphthylene, anthracene, 1,2-benzanthracene, 3, 4-benzofluoranthene, benzo[k}fluoranthene, 1,12-benzoperylene, benzo[a]pyrene, chrysene, dibenzo[ah]anthracene, fluorine, indeno[1,2,3-cd]pyrene, phenanthrene and pyrene.

Both of the ocean mixing zone sites exceeded the Ocean Plan WQO for total suspended solids (TSS). The Ocean Plan states that the level, "must be 75% lower than the influent." This WQO was also exceeded during the dry weather and could be attributed to two factors; (1) sediment into the sample from surf zone activity, and (2) incomplete initial dilution due to the inability to get further into the mixing zone due to safety concerns. During dry weather, the mass loading station results were non-detectable. Therefore, the higher TSS level was most likely a result of the wave action in the mixing zone. In order to verify the TSS and residual chlorine exceedances, these analytes were also sampled during the second wet weather event. The results are presented is Table 3-7.

Table 3-7. Select analytical results for the MLS and ocean mixing zones during the second wet weather event.

Constituent	BGO	BG1
TSS (mg/L)	7.3	72
Residual Chlorine (mg/L)	**0.091**	Not Sampled

During the second wet weather event, care was taken to minimize sediment collection in the surf zone area. The Ocean Plan WQO for TSS was not exceeded during this event. The Basin Plan WQO for TSS states, "inland surface waters shall not contain suspended or settleable solids in amounts which cause a nuisance or adversely affect beneficial uses as a result of controllable water quality factors." Because there is not a quantitative objective, the results of the TSS analysis in the freshwater samples are not identified as exceedances.

The residual chlorine WQO was exceeded again at the Buck Gully Ocean site. Chlorine is added to the municipal water supply as a control for microbes. The 2006 Irvine Ranch Water District (IRWD) Municipal Water Quality Report lists an average residual chlorine level of 2.0 ppm (the equivalent of mg/L). The IRWD Reclaimed Water Quality Report presents an average level of 10 mg/L of residual chlorine in its Michelson Water Reclamation Plant effluent (IRWD 2001).

IRWD provides reclaimed or non-potable water for residential irrigation. Based on the findings of the Buck Gully Dry Weather Investigation and Todd Engineer's Groundwater Investigation, residential irrigation runoff is a likely source of the residual chlorine found in Buck Gully either from direct runoff or groundwater seepage from irrigation infiltration.

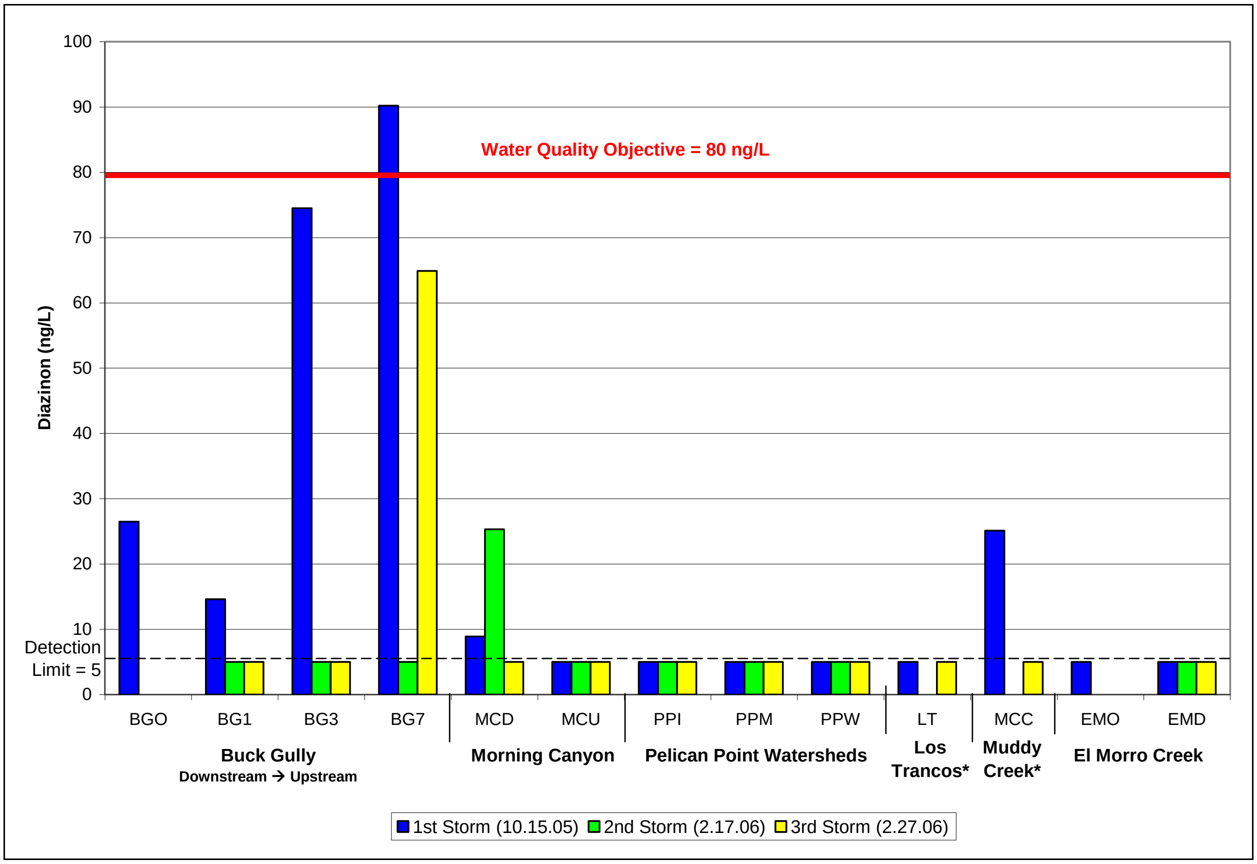
Also detected during the first wet weather events were dioxins. As discussed in the dry weather results, the TCDD Equivalents value is a calculation which sums the concentrations of chlorinated dibenzodioxins (2,3,7,8-CDDs) and chlorinated dibenzofurans (2,3,7,8-CDFs) multiplied by their respective toxicity factors. While there are not WQO specifically listed in the Basin Plan, these constituents, detected in Buck Gully and El Morro, are greater than the Ocean Plan WQO. Sources detailed in the dry weather results section include industrial emissions and some herbicides.

The results at the ocean mixing zones from the first wet weather event for total Ocean Plan PAHs are above the 30-day average value. However, they were not identified as exceedance due to the short term nature of stormwater. Possible sources of PAHs are asphalt, forest fires or aerial deposition from other sources of combustion.

The presence of 1,4-dichlorobenzene in Buck Gully and El Morro Creek was detected in the first dry and wet weather events, however, they were non-detect in all ocean samples. Dichlorobenzenes do not occur naturally. 1,4-Dichlorobenzene is a solid with a strong odor used in air fresheners, mothballs and toilet deodorizers. The Agency for Toxic Substances and Disease Registry (ATSDR) states that dichlorobenzenes do not dissolved easily in water. The small amounts that reach the water almost immediately evaporate into the air. They do, however, sometimes bind to sediments and soil (ATSDR 2004).

Organophosphate pesticides were analyzed in all sites for all three storm events. Chlorpyrifos and diazinon have WQOs set by the California Department of Fish and Game (CDFG 2000). None of the sites had detectable levels of chlorpyrifos. Figure 3-8 presents the results for diazinon analysis. Diazinon was detected in Buck Gully during the first wet weather event at all sites. It was also detected at the most upstream site during the third wet weather event. In addition, the Buck Gully Ocean site sampled during the first wet weather event did have detectable levels of diazinon. The only exceedances occurred at the most upstream site in Buck Gully, BG7, during the first storm event. The data suggests that a potential diazinon source is located upstream in Buck Gully, above site BG7. The source is likely pesticide application in residential areas that result in residual levels in soils and on vegetated surfaces that is transported by storm water to Buck Gully Creek.

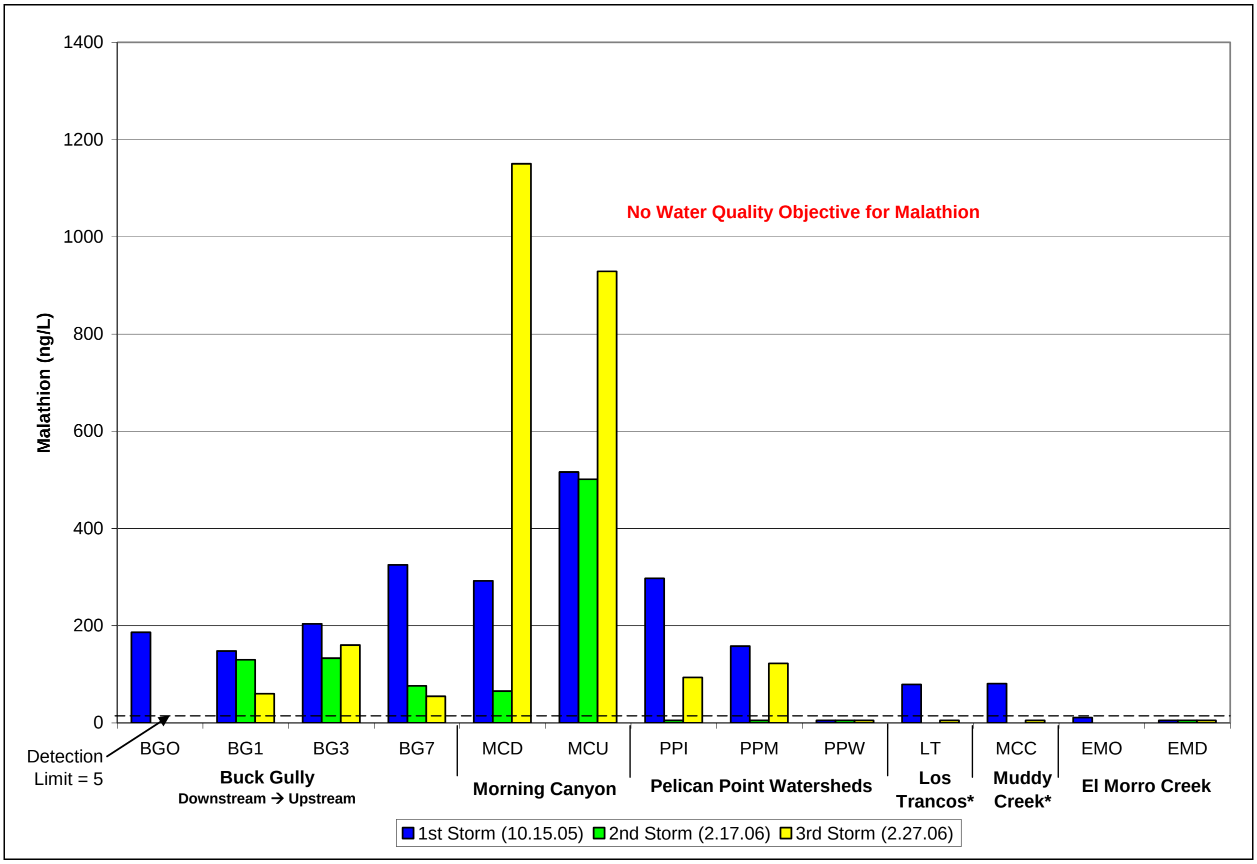
Other creeks with detections of diazinon included Morning Canyon and Muddy Creek. Diazinon is an insecticide used to control pest insects in the soil, gardens, and lawns. As of December 31, 2004, the EPA has eliminated the residential use of the insecticide in the United States due to a toxic effect on birds, fish and bees (EPA 2005a). However, many homeowners still possess diazinon purchased before the EPA ban, and it remains a popular method of insect control. Although diazinon was detected in Morning Canyon and Muddy Creek, diazinon did not exceed reporting limits in either canyon.



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

Figure 3-8. Diazinon results during wet weather events.

Another organophosphate pesticide found in the Newport Coast Watersheds is malathion. Malathion is used widely as an insecticide on agricultural crops. It is also used in residential ornamental and vegetable gardens and in the eradication effort of boll weevils, white fly, and fruit flies. Other registered uses include golf courses. It is currently undergoing re-registration by the EPA and toxicity concerns are under review (EPA 2005b). Aquatic invertebrates may exhibit toxic effects at concentrations above 1,000 ng/L (EXTOXNET 1993). Malathion is present in most of the Newport Coast creeks. The exceptions are Pelican Point Waterfall Creek (PPW) and El Morro Creek. However, it is interesting to note that the ocean mixing zone site at El Morro did detect malathion at a level of 10 ng/L, although the corresponding mass loading station had a non-detect result. Figure 3-9 presents the wet weather malathion results for all of the Newport Coast watersheds. Morning Canyon had the highest levels of malathion detected in all of the canyons. Again, the data trend suggests that the source of malathion in Buck Gully is from upstream, above site BG7.



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

Figure 3-9. Malathion results during wet weather events.

Synthetic pyrethroids were also analyzed at the two mass loading stations in Buck Gully and El Morro. Synthetic pyrethroids were created to act in a similar manner to pyrethrins, which are an insecticide derived from chrysanthemum flowers (EPA 2002). The pyrethroid consistently detected in Buck Gully is bifenthrin. There were no synthetic pyrethroids found in El Morro Creek. Results of bifenthrin were found between 7.8 and 39.7 ng/L. Bifenthrin is a restricted use pesticide that is only lawfully sold to and used by registered professionals. It has been found to be toxic to fish and aquatic organisms (USDA 1998).

The total and dissolved forms of metals were analyzed for all sites. The Ocean Plan lists WQOs for the total recoverable form of cadmium, copper, lead, mercury, nickel, selenium, silver, and zinc. The California Toxic's Rule (CTR) lists hardness-based WQOs for the total and dissolved recoverable forms of arsenic, cadmium, chromium III, copper, lead, mercury, nickel, silver, and zinc. Table 3-8 provides a comparison of total metals for the ocean samples and the corresponding mass loading station samples. Table 3-9 presents the total cadmium, copper, and zinc results for the sites at the mouth of the canyons. Although the CTR has criteria for both total and dissolved metals, the WQOs for freshwater are based on dissolved metals which are generally more bio-available to potential ecological receptors.

Table 3-8. Total metals results for the first wet weather event at the MLS and ocean mixing zone sites.

	Ocean Plan WQO		Freshwater WQO	Results			
Total Recoverable Metals (µg/L)	Instantaneous Max	Daily Max (shown as reference not as exceedance)	CTR CMC[1]	BGO	BG1	EMO	EMD
Arsenic	80	32	340	4.3	3.04	1.82	3.34
Cadmium	10	4	21.58	**10.2**	3.75	0.291	1.15
Copper	30	12	51.68	29.3	31.4	2.56	11.4
Lead	20	8	476.82	2.85	1.54	1.5	3.01
Mercury	0.4	0.16	1.4	0.0285	<0.01	0.0072	0.019
Nickel	50	30	1515.92	27.9	19.6	2.81	17.5
Selenium	150	60	N/A	37.4	46	0.118	6.17
Silver	7	2.8	44.05	<0.1	<0.01	<0.005	<0.01
Zinc	200	80	387.83	47.8	32.6	12.3	37.4

1 – CTR CMC is the California Toxics Rule Criteria Maximum Concentration (CMC). As defined by the EPA, the CMC is an estimate of the highest concentration of a material in surface water to which an aquatic community can be exposed briefly without resulting in an unacceptable effect.

Table 3-9. Total cadmium, copper, and zinc results for the sites at the mouth of the coastal canyons.

Stream	Storm Event	Total Cadmium (µg/L)	Total Copper (µg/L)	Total Zinc (µg/L)
Ocean Plan Instantaneous Maximum WQO (Shown as a reference not as exceedance.)		**10**	**30**	**200**
Exceedances are based on the CTR CMC WQO for the total recoverable form of the metal[1].				
Buck Gully (BG1)	1 (10.17.06)	3.75	31.4	32.6
	2 (2.19.06)	**21.9**	26.7	65.9
	3 (2.28.06)	8.08	23.2	40.2
Morning Canyon (MCD)	1 (10.17.06)	**109**	**96**	234
	2 (2.19.06)	**29.8**	48.2	**460**
	3 (2.28.06)	20.3	**66.3**	**417**
Pelican Point (PP1)	1 (10.17.06)	**21.1**	**129**	**302**
	2 (2.19.06)	**27.2**	**1300**	**1250**
	3 (2.28.06)	3.79	**116**	**1020**
Pelican Point Middle Creek (PPM)	1 (10.17.06)	**69.4**	26.4	62
	2 (2.19.06)	**47**	13.1	48.5
	3 (2.28.06)	**183**	39.1	155
Pelican Point Waterfall Creek (PPW)	1 (10.17.06)	**23.9**	**38.8**	**343**
	2 (2.19.06)	**19.3**	33.3	151
	3 (2.28.06)	**15.1**	**23.7**	116
El Morro Creek (EMD)	1 (10.17.06)	1.15	11.4	37.4
	2 (2.19.06)	2.17	11	18.3
	3 (2.28.06)	3.27	9.47	27.6

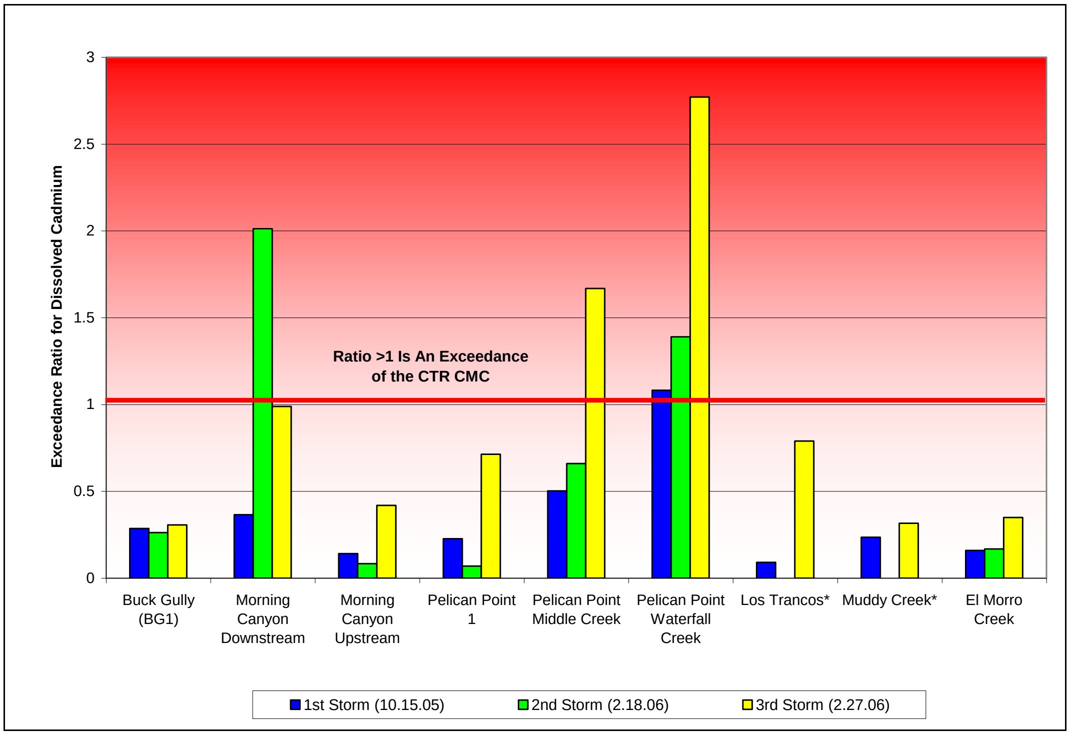
1 - Exceedances shown in red and bold are exceedances of the CTR CMC WQO. These exceedances are hardness based objectives and the value of the objective varies depending on the site and storm event.

The only exceedance of the Ocean Plan WQOs was at the Buck Gully Ocean site (BGO) for total cadmium. The total cadmium concentration at the mass loading station (BG1) was less than in the mixing zone and did not exceed the freshwater WQOs. This indicates the exceedances at Buck Gully Ocean (BGO) may not be a result of the Buck Gully effluent. Total cadmium for the second storm did exceed the CTR CMC WQO.

Neither the El Morro Ocean site (EMO) nor the El Morro Downstream site (EMD) exceeded the saltwater or freshwater water quality objectives. Although ocean mixing zone samples were not taken at the other coastal outfalls, Table 3-9 presents select total metals results at the mouth of the creeks. Freshwater total cadmium results exceeded water quality objectives in the majority of storm events in Morning Canyon and all of the Pelican Point watersheds. Total copper freshwater WQOs were exceeded in Morning Canyon and two of the three Pelican Point watersheds (PP1 and PPW). Total zinc freshwater WQOs were exceeded at the mouth of Morning Canyon and PP1 and once at PPW.

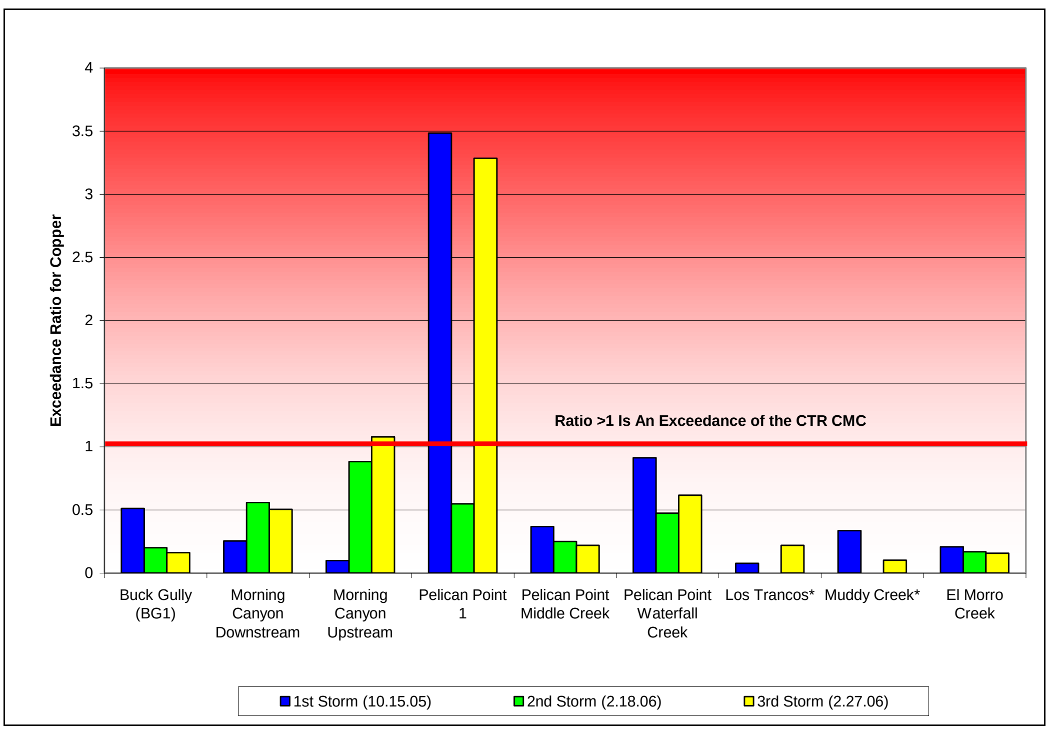
As previously stated, the freshwater WQO are derived from the dissolved form of the metals which are generally more bio-available to ecological receptors. The only exceedances of the dissolved fractions of metals were for cadmium and copper. Figure 3-10 and Figure 3-11 show the exceedances ratios for the dissolved fractions of these two metals for all three storms across the watersheds. Ratios greater than one indicate an exceedances. Pelican Point Waterfall Creek (PPW) repeatedly exceeded the dissolved cadmium WQO during wet weather. Other exceedances were at PPM and Morning Canyon Downstream. Dissolved copper results exceeded WQO during the first and third storm events at PP1. The other exceedance was during the third storm event at Morning Canyon Upstream.

Figure 3-12 presents the dissolved cadmium and copper results specifically for Buck Gully. There is no observable trend in dissolved metals for the three storm events samples in relation to identifying a relationship to increase or decreasing concentrations at sample location or up and downstream in the canyon. There are no exceedances of the water quality objectives for dissolved metals in Buck Gully. A defined single or specific set of sources of metals concentrations was not identified; rather the metal constituents detected in the storm samples are characteristic of non-point source wet weather flows. In evaluating the potential non-point sources of the constituents the land use in the Buck Gully watershed is predominantly residential with limited commercial uses along Pacific Coast Highway.



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

Figure 3-10. Exceedance ratio for wet weather dissolved cadmium results.



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

Figure 3-11. Exceedance ratio for wet weather dissolved copper results.

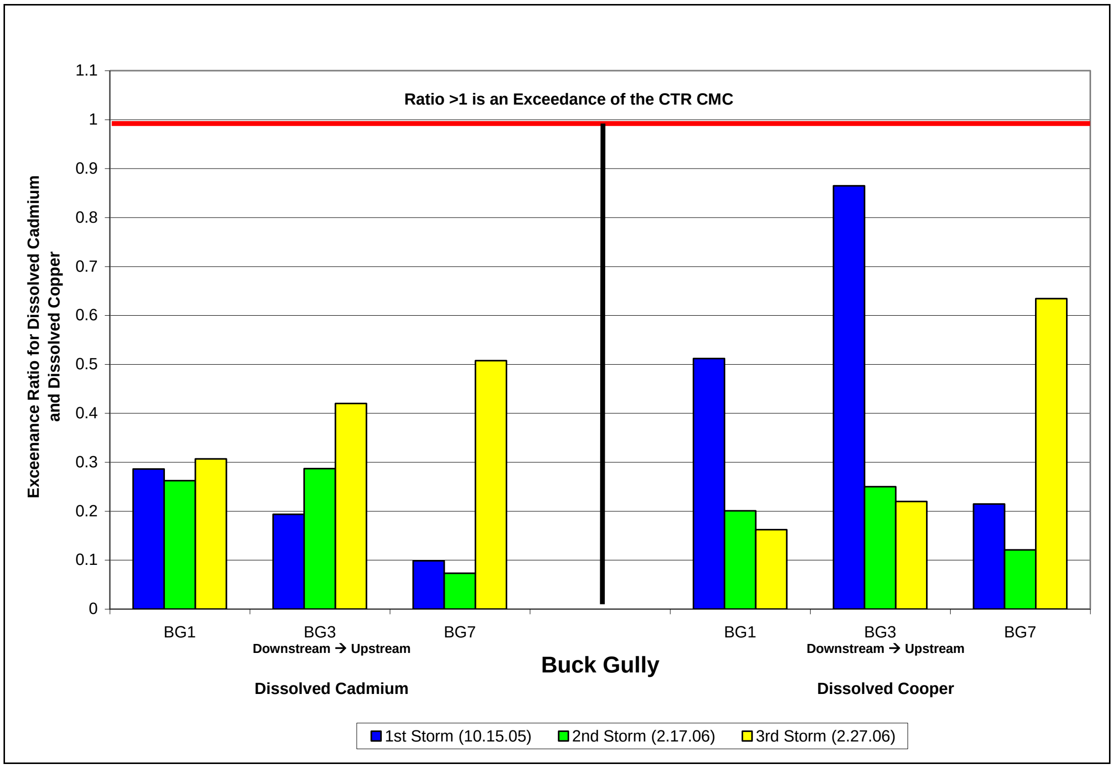
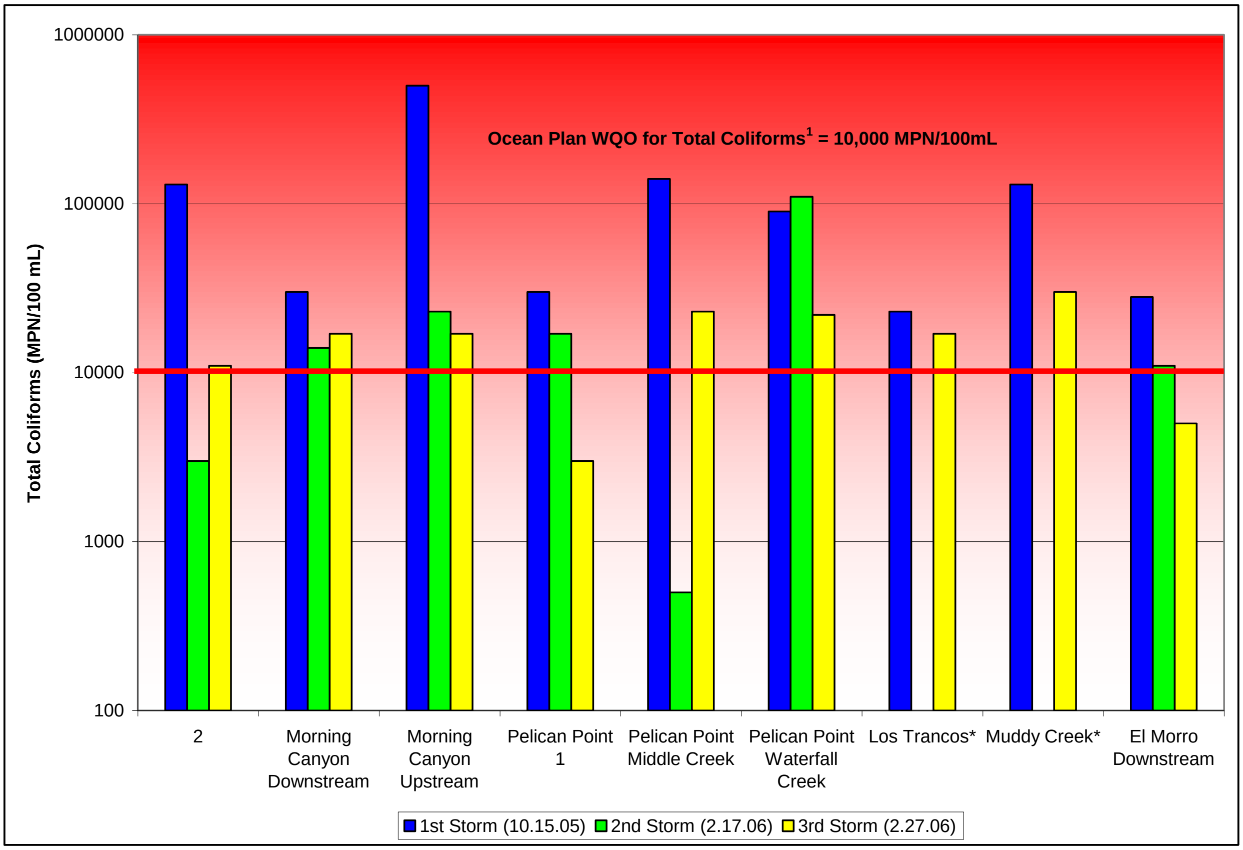


Figure 3-12. Exceedance ratios for dissolved cadmium and dissolved copper in Buck Gully.

As discussed in the dry weather results section, cadmium and copper does occur naturally in geological formations. In comparing the cadmium and copper concentrations at the reference (El Morro) canyon with Buck Gully, background concentrations may be 30-50 percent of the concentrations detected in the developed watershed. Cadmium is also found in phosphate fertilizers that are available commercially. The use of these fertilizers by landscapers for residential properties could be a potential source. The EPA also reports that cadmium salts have had a very limited use as a fungicide for golf courses. The Pelican Hill Golf Course comprises only a small portion of the Buck Gully watershed. The use of these pesticides at the golf course should be investigated to rule out this low probable source.

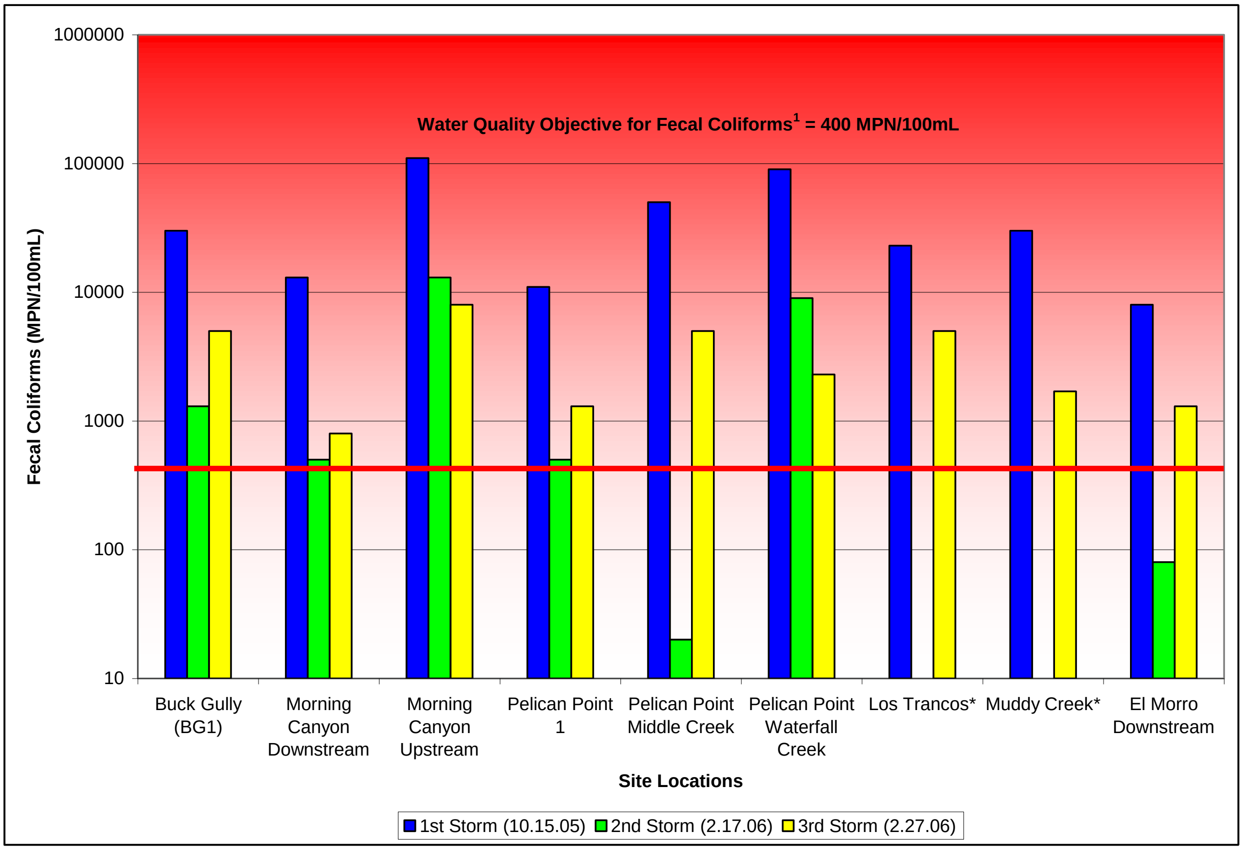
As expected during wet weather, bacteria levels are higher than during the dry weather events. The majority of the sites sampled exceeded bacterial indicator WQOs. The revised 2005 California Ocean Plan added single sample bacterial maximum criterion. The total coliform maximum criterion is 10,000 MPN/100mL. The redline exceedance level shown on Figure 3-13 is therefore not applicable to the freshwater samples collected from the mouths of the canyon creek, but is shown for comparison purposes with the ocean samples also discussed in this sub-section. The Ocean Plan WQOs for fecal coliforms and Enterococci are the same as AB411 freshwater standards commonly used throughout the state as beach closure guidelines. These WQOs are 400 and 104 MPN/100mL, respectively. The Santa Ana Basin Plan provides a WQO for fecal coliforms. While the Basin Plan narrative describes a 30-day mean objective, the single sample exceedance of 400 MPN/100mL is used conservatively here as a comparison. The exceedance level shown on Figure 3-14 is therefore conservative. Furthermore, the redline WQO exceedance line shown on Figure 3-15 is not applicable to the freshwater samples collected from the mouths of the canyon creek, but is shown for comparison purposes with the ocean samples also discussed in this sub-section.

Because bacteria are a living organism, bacteria population numbers are variable in the environment and vary from sample to sample and event to event. Thus, the bacterial results are presented on a log scale in Figure 3-13 through Figure 3-17. Significant differences in bacterial numbers are generally shown by orders of magnitude.



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.
[1] The Ocean Plan WQO is applicable to ocean samples only and is presented as a reference.

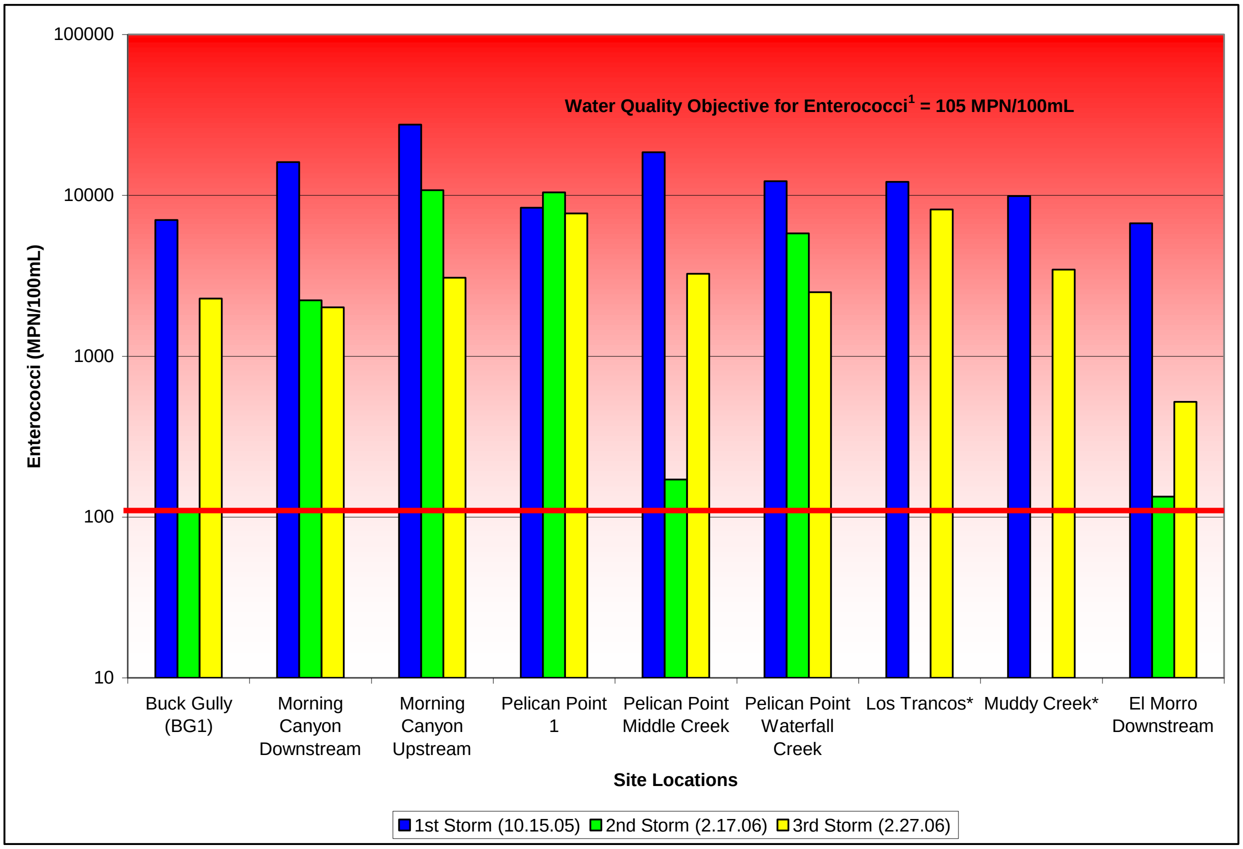
Figure 3-13. Total coliform results during wet weather.



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

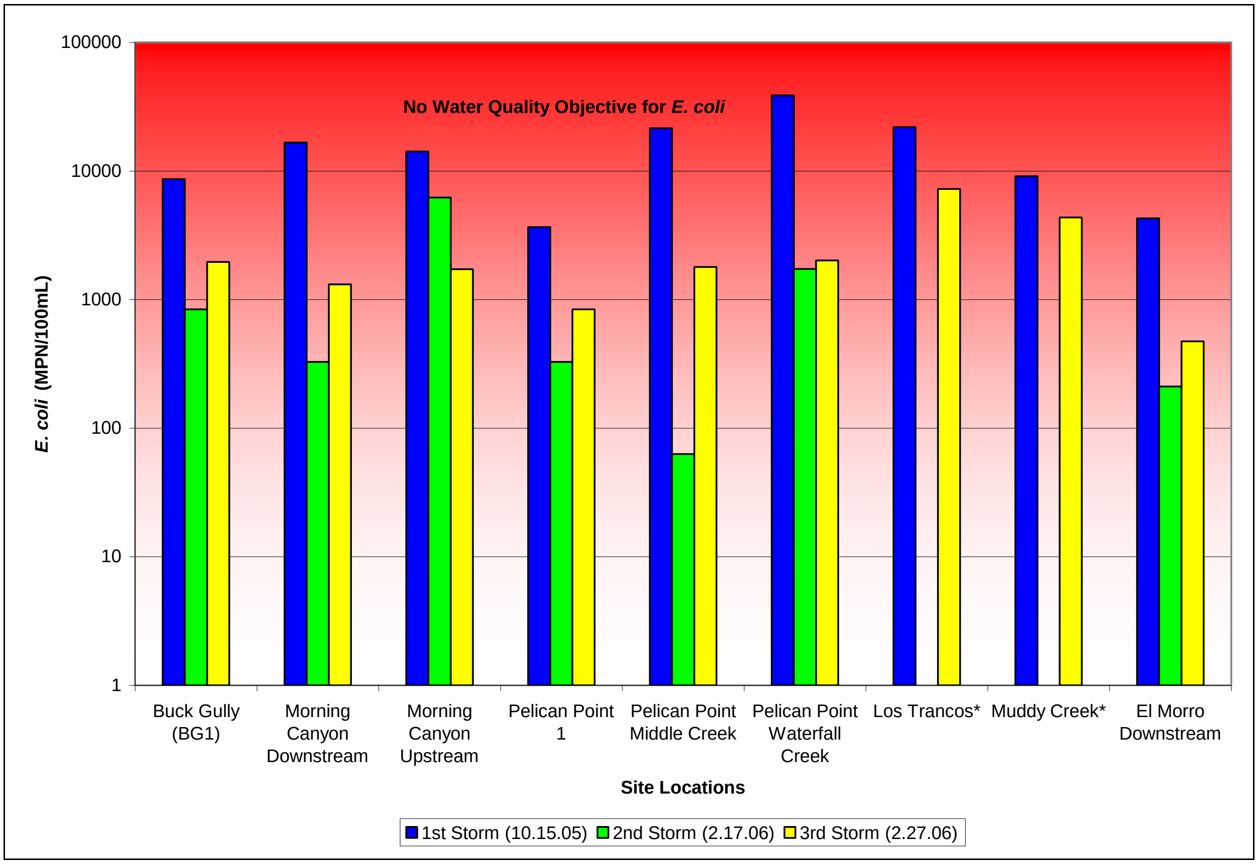
[1] The Ocean Plan WQO for fecal coliforms is 400 MPN/100mL. The Basin Plan WQO for fecal coliforms is, "log mean less than 200 MPN/100mL based on five or more samples/30 day period, and not more than 10% of the samples exceed 400 MPN/100mL for any 30-day period."

Figure 3-14. Fecal coliform results during wet weather.



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.
[1] The Ocean Plan WQO is applicable to ocean samples only and is presented as a reference.

Figure 3-15. Enterococcus results during wet weather.



* Los Trancos and Muddy Creek sites were not sampled during the second wet weather event. The data from the third storm event was collected by the Irvine Company.

Figure 3-16. *E. coli* results during wet weather.

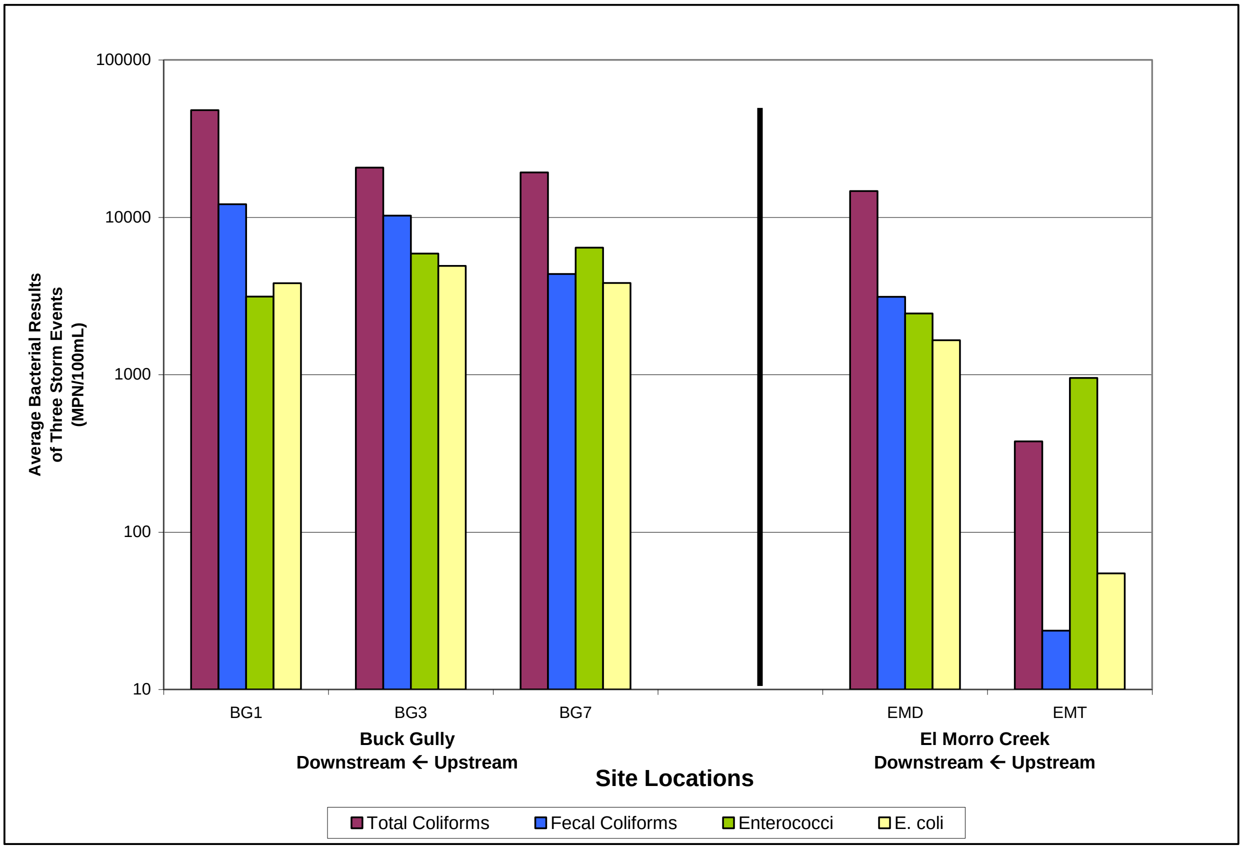


Figure 3-17. Average bacterial indicator results for wet weather in Buck Gully and El Morro Creek.

As shown in Figures 3-13 to 3-17, the bacterial indicator results for the first wet weather event are generally an order of magnitude higher at nearly all the locations in the Newport Coast Watershed. These results indicate a possible first-flush phenomenon. Although there had been one storm event prior to the first sampling event on September 20, 2005. This early storm event produced less than 0.15 inches of rain.

The concentrations of bacteriological indicators at the downstream location in El Morro canyon exceed the WQO for total coliforms, fecal coliforms, and Enterococci. Although there are potential anthropogenic sources of bacteria (trailer park) in this watershed, more than 90 percent of the drainage area is undeveloped. These results suggest non-anthropogenic source of bacteria contributing to the exceedances in this and other coastal canyon watersheds.

The ocean sites were only sampled during the first storm event, so the variability between storms is unknown. Table 3-10 presents the results from the ocean mixing zones and corresponding MLSs during the first storm event. While the El Morro MLS site did exceed all applicable WQOs, the ocean site did not exceed the total and fecal coliforms WQOs. Enterococci tends to be more robust and can survive longer in saltwater than fecal or total coliforms.

Table 3-10. Bacteria Indicator Results from the Ocean Mixing Zone and MLS Sites during the First Wet Weather Event.

Bacterial Indicator (MPN/100mL)	Buck Gully Creek		El Morro Creek	
	BGO	BG1	EMO	EMD
Total Coliforms	**50,000**	130,000	700	28,000
Fecal Coliforms	**13,000**	**30,000**	140	**8,000**
Enterococcus	**10,168**	7,027	**145**	6,695
E. coli	9,326	8,624	158	4,284

In Buck Gully, bacterial indicator results are similar throughout the watershed for each of the storm events as shown on Figure 3-17. There is a slight increase in total coliform, fecal coliform, and *E. coli* moving downstream, but a slight decrease in Enterococcus. The Buck Gully Ocean site was sampled during the first wet weather event and did exceed the WQOs available from the Ocean Plan. The corresponding mass loading station site, BG1, also exceeded all freshwater WQOs for fecal indicator bacteria (Table 3-10).

As present in Figure 3-17, the first wet weather event indicated that bacterial indicators in Morning Canyon decrease from the upstream to the downstream site. The additional storm events sampled show that for fecal coliforms, this was consistently true. However, for the other indicator bacteria, results were similar from the upstream to the downstream sites. The variable nature of coliforms likely accounts for this difference.

3.5.2 Toxicity

Two composite samples were collected for toxicity testing. During the second storm event, a composite sample was collected at the mixing zone where Buck Gully enters the Pacific Ocean (BGO), and analyzed for acute and chronic toxicity. A composite sample was also collected from the third storm event at the mass loading station on Buck Gully (BG1). This freshwater sample was analyzed for acute toxicity only.

Three marine organisms were chosen for the chronic toxicity tests, in accordance with the Ocean Plan: *Macrocystis pyrifera* (giant kelp), *Mysidopsis bahia* (mysid shrimp), and *Strongylocentrotus purpuratus* (purple urchin). The acute toxicity tests performed during both the second and third storm events were on *M. bahia*. The salinity of the sample BGO was outside of the criteria range for testing with the selected marine species. For this reason, a hypersaline brine was added to the test samples in order to increase the salinity of sample BGO from 19.3-19.4 ppt to the following salinities: 33.0 ppt for the *M. pyrifera* test, 34.0 ppt for *S. purpuratus* test, and 25.0 ppt for the acute and chronic *M. bahia* test. Salinity adjustment with hypersaline brine was also necessary on the freshwater sample BG1, raising the salinity from 0.3 ppt to 25.0 ppt. Results of the bioassay tests are provided below in Table 3-11.

Table 3-11. Aquatic toxicity test results for the second and third wet weather event at the MLS and ocean mixing zone sites.

BGO (2.17.06)					
Chronic Toxicity Tests					
Test	**Endpoint**	**NOEC (%)**	**LOEC (%)**	**EC_{50} (%)**	**TU_c**
***M. pyrifera* (giant kelp)**	Germination	25	50	>75	4
	Growth	75	>75	>75	1.33
M. bahia (mysid shrimp)	Survival	85	>85	>85	1.18
	Biomass	85	>85	>85	1.18
***S. purpuratus* (purple urchin)**	Proportion Fertilized	75	>75	>75	1.33
Acute Toxicity Test					
M. bahia (mysid shrimp)	Survival	90	>90	>90	0.23
BG1 (2.27.06)					
Acute Toxicity Test					
M. bahia (mysid shrimp)	Survival	70	>70	>70	0.41

The Ocean Plan lists water quality objectives as less than 1 Toxic Unit for both chronic (TUc) and acute (TUa) endpoints. Based solely on this requirement, sample BGO exceeds the water quality objectives for all chronic test species. However, the calculation for estimating the TUc values (100/NOEC) is dependent upon the testing of a 100% sample, and does not take into consideration the dilution factor applied when a sample must be adjusted for salinity. The addition of hypersaline brine to the samples dilutes that sample to a value less than 100%, as in these tests, where the highest concentration of actual sample in the adjusted tests range from 70 - 90% test substance. Table 3-12 summarizes the test results in relation to the maximum concentration of sample tested due to dilution.

All of the test results detailed above indicate that test substances BGO and BG1 did not have a toxic effect on the acute and chronic toxicity to marine organisms at the concentrations that were tested, with the exception of the kelp germination endpoint for sample BGO. In this test, the NOEC was determined to be 25% of the test solution while the Lowest Observable Effect Concentration (LOEC) was determined to be 50% of the test solution. This means that the percentage of kelp germination in the BGO 50% concentration was significantly different than in the control treatment. Based on these results, toxic effects on kelp germination would be expected in concentrations of 50% or greater BGO water. The specific cause of the toxicity on kelp germination can not be determined from these tests. In addition to the chemical constituents in the sample, the amount of sunlight (that can be affected by TSS) can also result in measured effects. A TIE test can be performed to better determine the potential causes of the measured toxicity effects.

Table 3-12. Toxicity test results in relation to maximum concentration tested.

BGO (2.17.06)				
Chronic Toxicity Tests				
Test	Endpoint	Highest Concentration Tested After Salinity Adjustment (% Sample)	No Observed Effect Concentration (NOEC)	Statistically Significant Difference Between Control and Highest Concentration
M. pyrifera (giant kelp)	Germination	75	**25**	**Yes**
	Growth	75	75	No
M. bahia (mysid shrimp)	Survival	85	85	No
	Biomass	85	85	No
S. purpuratus (purple urchin)	Proportion Fertilized	75	75	No
Acute Toxicity Test				
M. bahia (mysid shrimp)	Survival	90	90	No
BG1 (2.27.06)				
Acute Toxicity Test				
M. bahia (mysid shrimp)	Survival	70	70	No

The full toxicity reports are presented in Appendix E.

A further discussion of the ocean sample location in relation to the dilution levels is in Section 3.6.

3.5.3 Flow

All estimated wet weather flows are presented in Table 3-13. These flows were estimated based on the annual hydrograph as described in Subsection 2.3.2.3. Flows were estimated for each stream at the mouth based on the respective watershed areas and the modeled mean annual runoff rates during dry periods. Flows at Station EMD are the highest at 2.00 cfs due to the watershed area of this station nearly twice that of Buck Gully. Sample stations BG1, LTD, and MCC have calculated flows that are similar due to their similar watershed areas. Instantaneous flows measured showed a poor comparison with the estimated flows. The flow estimates were used for loading calculation since they are expected to be more representative of typical wet weather flows than using an instantaneous flow measured only at the time of sampling.

3.6 Ocean Sampling

An estimate of where complete plume mixing occurred was calculated based upon the salinity of the sample collected compared to a background salinity of 33 ppt. The results of this calculation show where in the dilution zone the samples were taken (Table 3-14). Since both sets of ocean samples were collected in the surf approximately 15 feet offshore, we can estimate that samples were collected near the end of the plume at Station EMO, and that samples at BGO were collected toward the middle of the plume.

Table 3-13. Wet weather flow data.

Station ID	Unit Modeled Flow (cfs)
Buck Gully	
BG1	1.18
BG2	1.08
BG3	1.03
BG4	0.89
BG5	0.69
BG6	0.46
BG7	0.29
Morning Canyon	
MCD	0.36
Pelican Point	
PP1	0.02
PPM	0.22
PPW	0.13
Los Trancos Canyon	
LTD*	1.10
Muddy Canyon	
MCC	0.93
El Morro Canyon	
EMD*	2.00

Table 3-14. Ocean sites estimated plume length.

	Season	BGO	EMO
Measured Salinity (ppt)	Dry	18.3	30.9
	Wet	2.2	29.8
Sample Distance from Shore (ft)	Both Events	15	15
Estimated Plume Length (ft)	Dry	22	16
	Wet	29	16

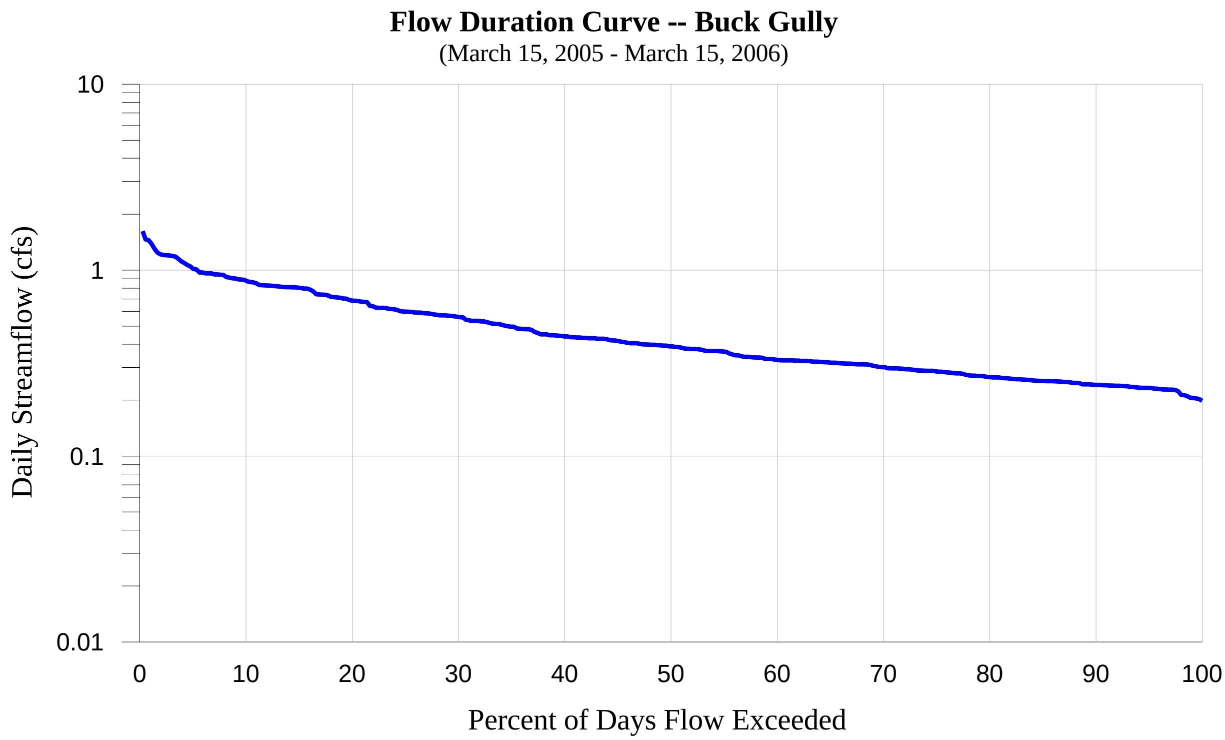
Calculated plume length based on Salinity Results and a standard seawater salinity of 33 ppt.

3.7 Loading

Flow duration curves for Buck Gully and Los Trancos, based on the multiple regression flow model show that the flow for both streams exceed 1.28 cfs (or $10^{0.11}$ cfs from the figure) one hundred percent of the time (Figure 3-18).

The Load Duration Curve describes where the Total Maximum Daily Load (TMDL) would be set assuming an implicit margin of safety. Load Duration Curves for cadmium, copper, lead, zinc, Fecal Coliform, and Enterococcus are presented below (Figure 3-19 through Figure 3-24). Examination of the Buck Gully Load Duration Curves reveals that, based on the estimated loads as sampled by Weston, the only dissolved metal to exceed either the acute or chronic water quality guideline is one dry weather sample of cadmium (Figure 3-19). This sample exceeded only the chronic WQO, not the acute. Sampled bacterial loads in Figure 3-23 indicate that the fecal coliform WQO was exceeded in all three wet weather but neither of the dry weather sampling events. The Enterococcus Ocean Plan standard was exceeded during all sampling events at Buck Gully. Also, the estimated loads as plotted on the graph show that no samples were collected during extreme low flow periods at Buck Gully. Therefore, for fecal coliform, the TMDL at Buck Gully would not be met during wet weather flow events. If the TMDL goals for Enterococcus were created for freshwater with the same water quality objectives of the Ocean Plan, then they would not be met for both wet and dry weather flow events.

The Load Duration Curves for Los Trancos show that, when compared to Buck Gully, all estimated daily load values plotted on the graphs are from wet weather events, hence their location at the far left on all plots. One similarity to Buck Gully Load Duration Curves is that actual daily loads as sampled by Irvine Company for cadmium indicate that one sample exceeded the chronic water quality guideline (Figure 3-19). This cadmium exceedance, however, is during wet weather while at Buck Gully the exceedance is during dry weather. This may indicate that there is a difference between cadmium sources when comparing the two canyons. All other dissolved metals are well below both the acute and chronic water quality guidelines. As at Buck Gully, fecal coliform and Enterococcus both exceeded the WQOs during wet weather for the one sample collected by Weston included on the plots. Therefore, if the TMDL goals for Enterococcus were created for freshwater with the same water quality objectives of the Ocean Plan, then they would not be met for wet weather flow events for both fecal coliform and Enterococcus at Los Trancos.



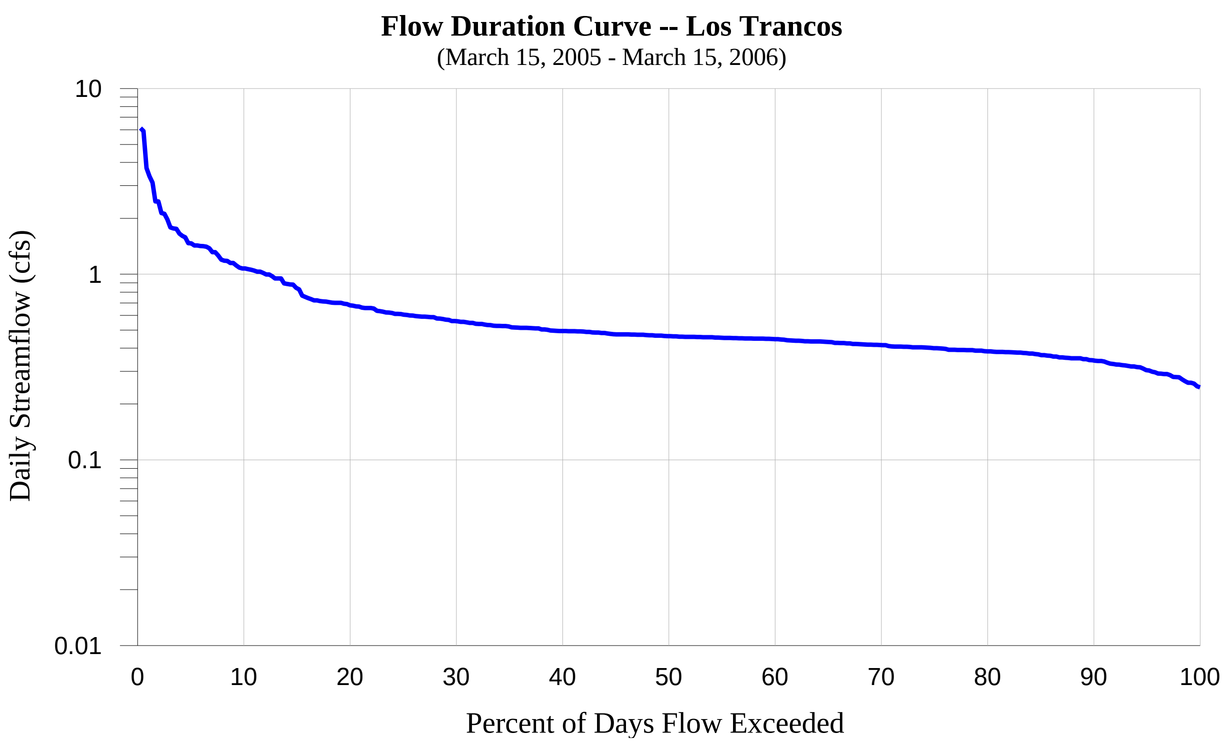
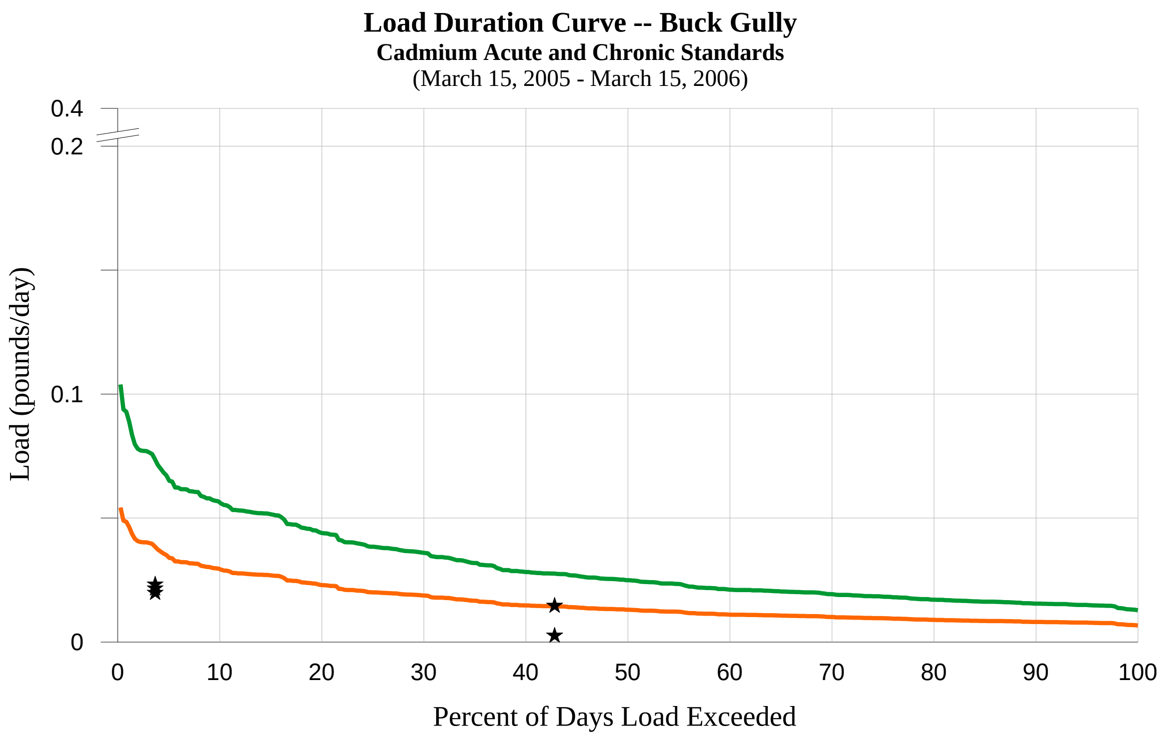


Figure 3-18. Flow duration curves for Buck Gully and Los Trancos.



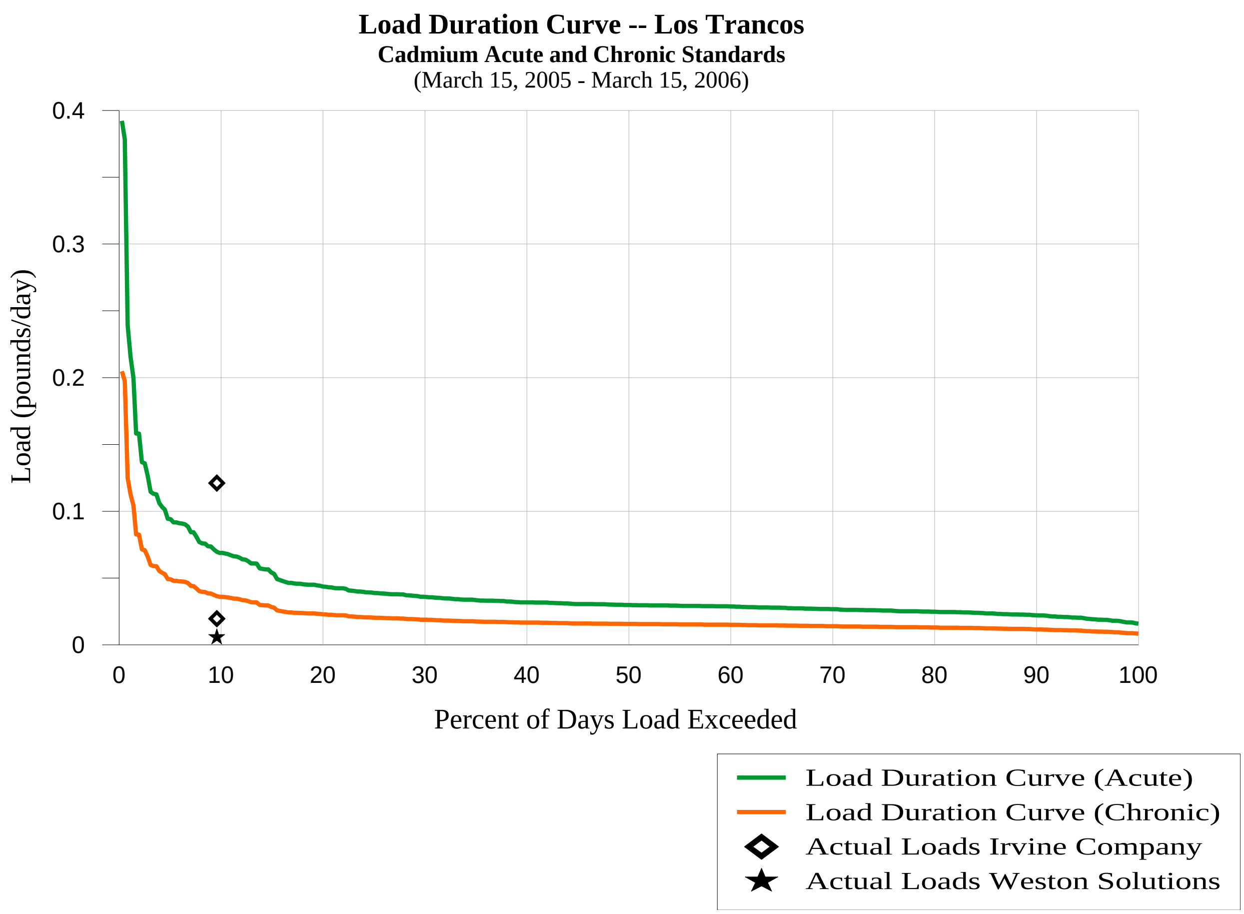


Figure 3-19. Load duration curves for cadmium.

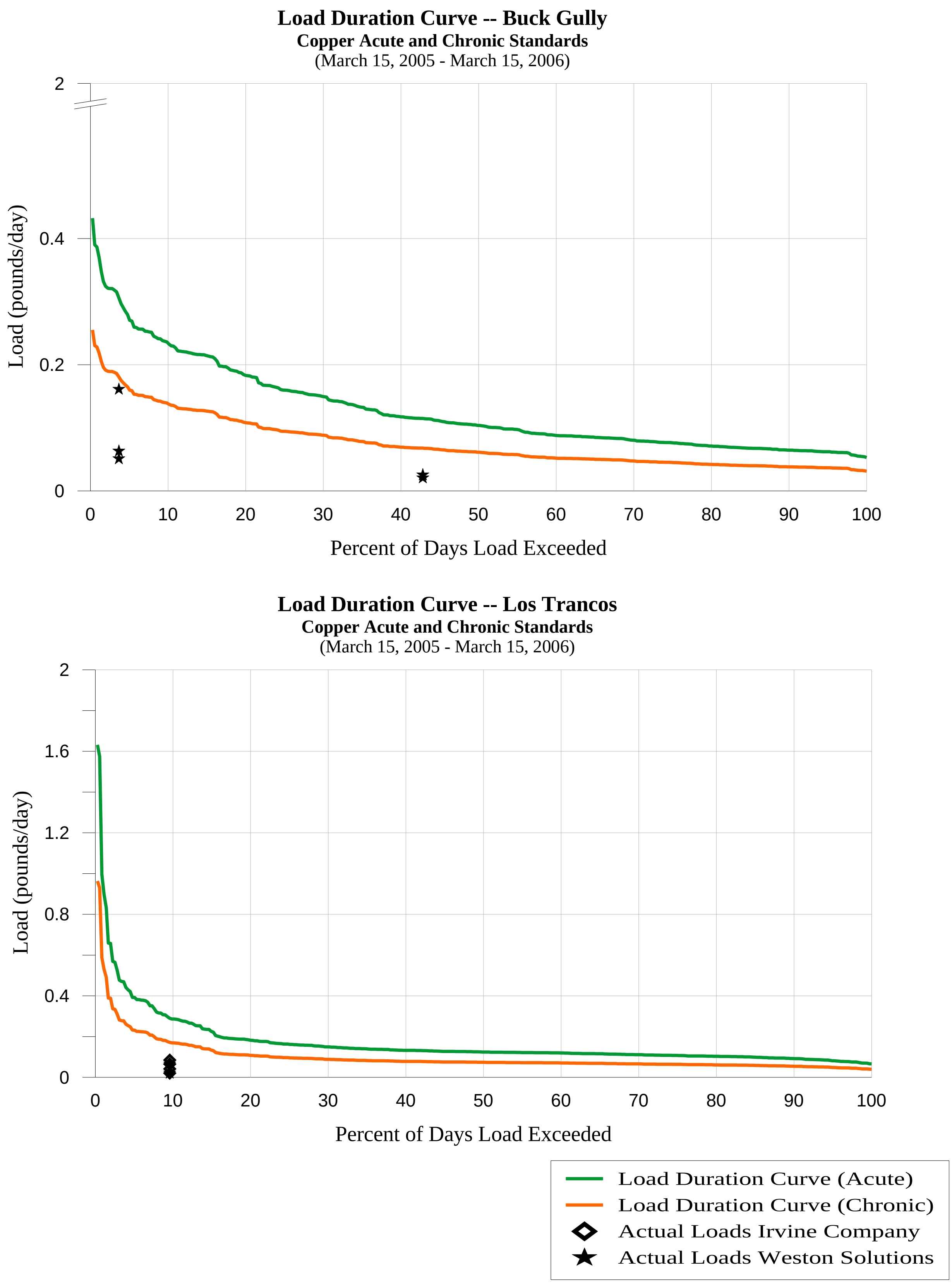


Figure 3-20. Load duration curves for copper.

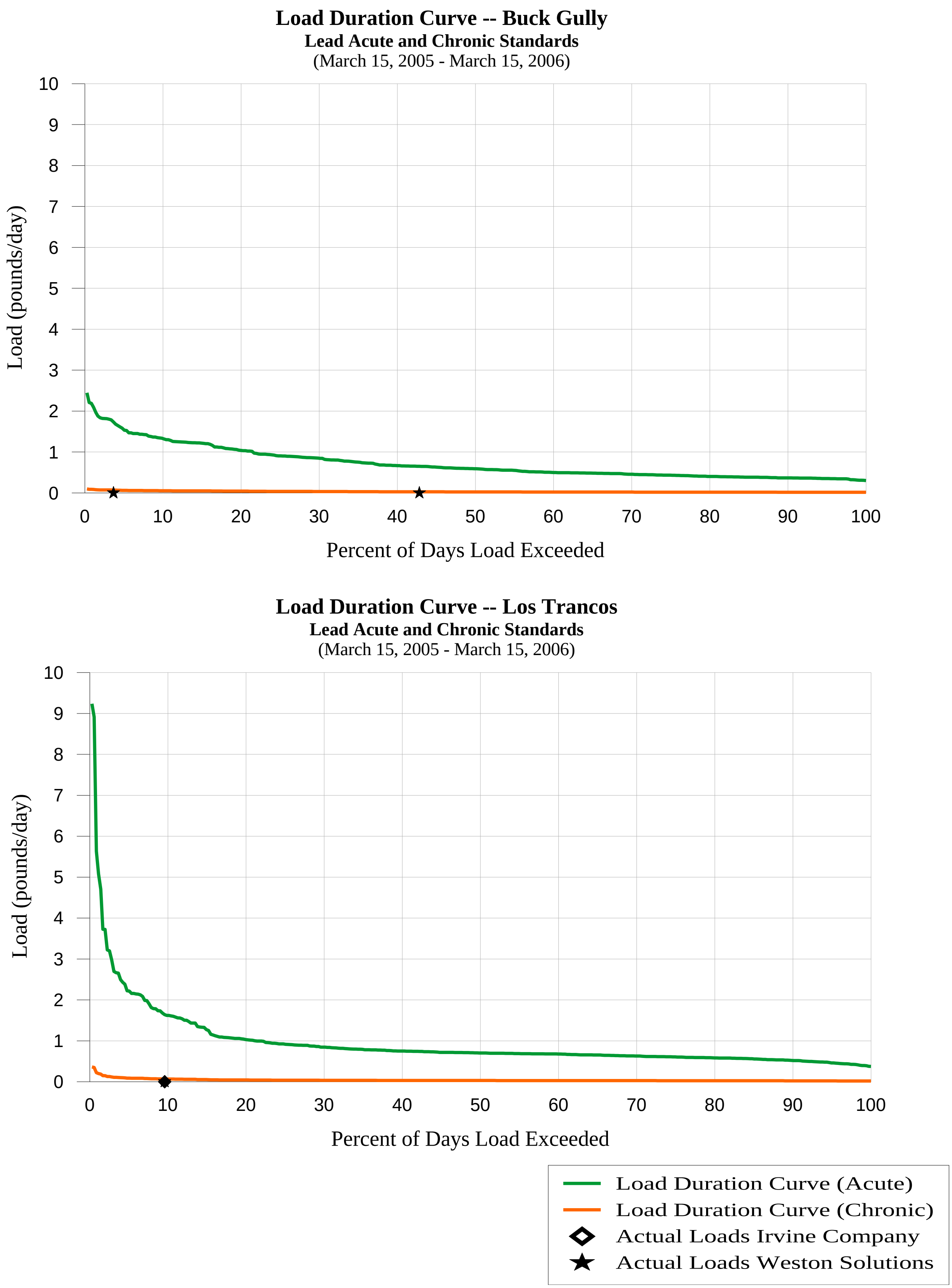


Figure 3-21. Load duration curves for lead.

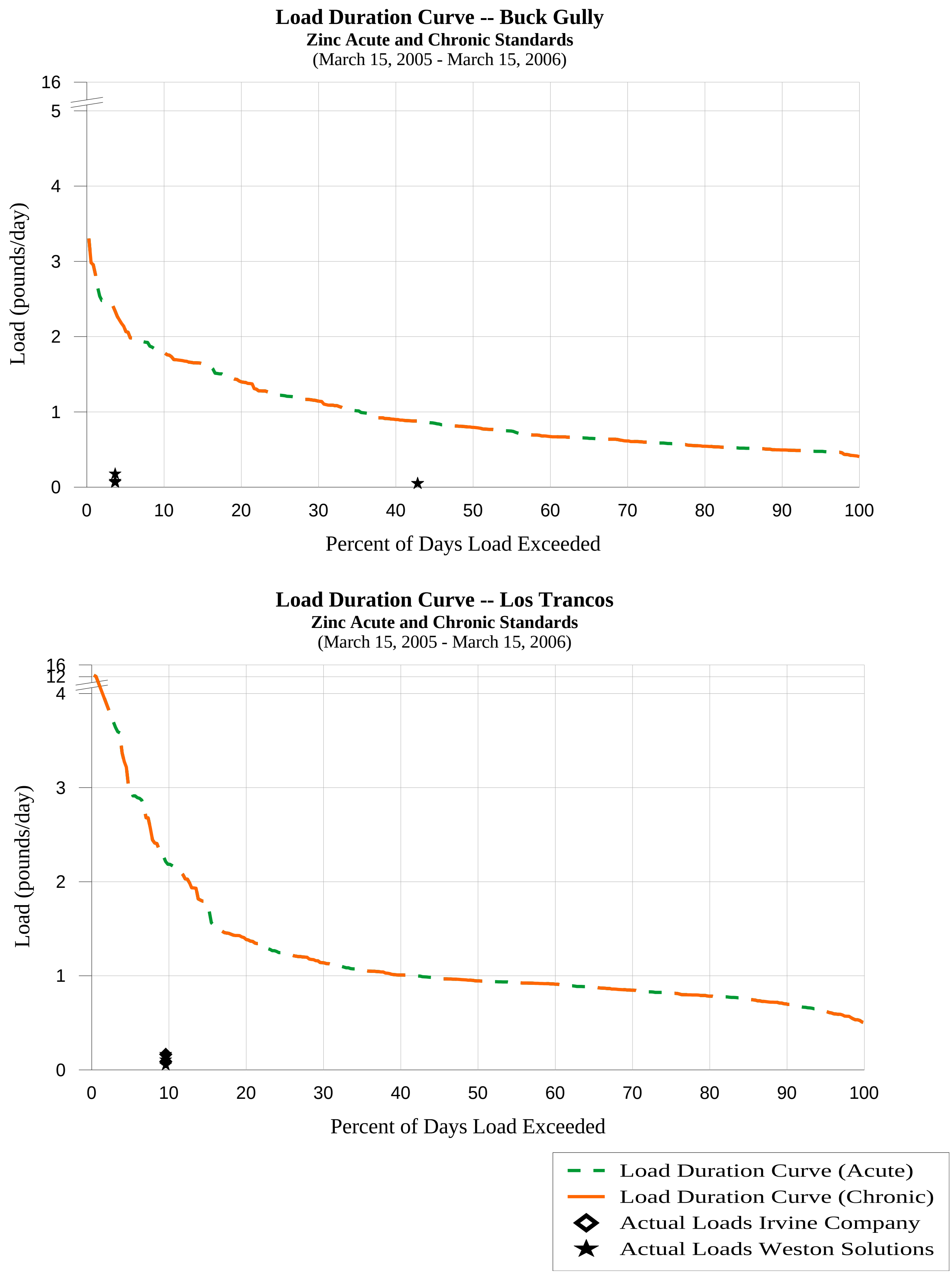
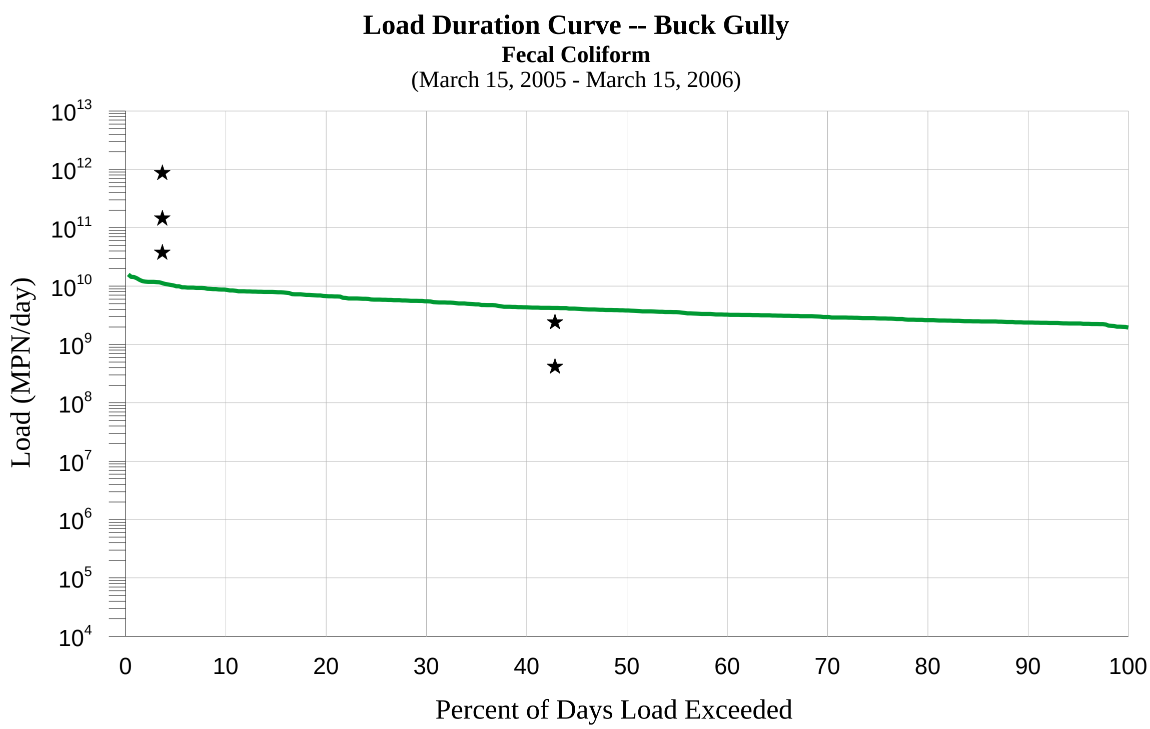


Figure 3-22. Load duration curves for zinc.



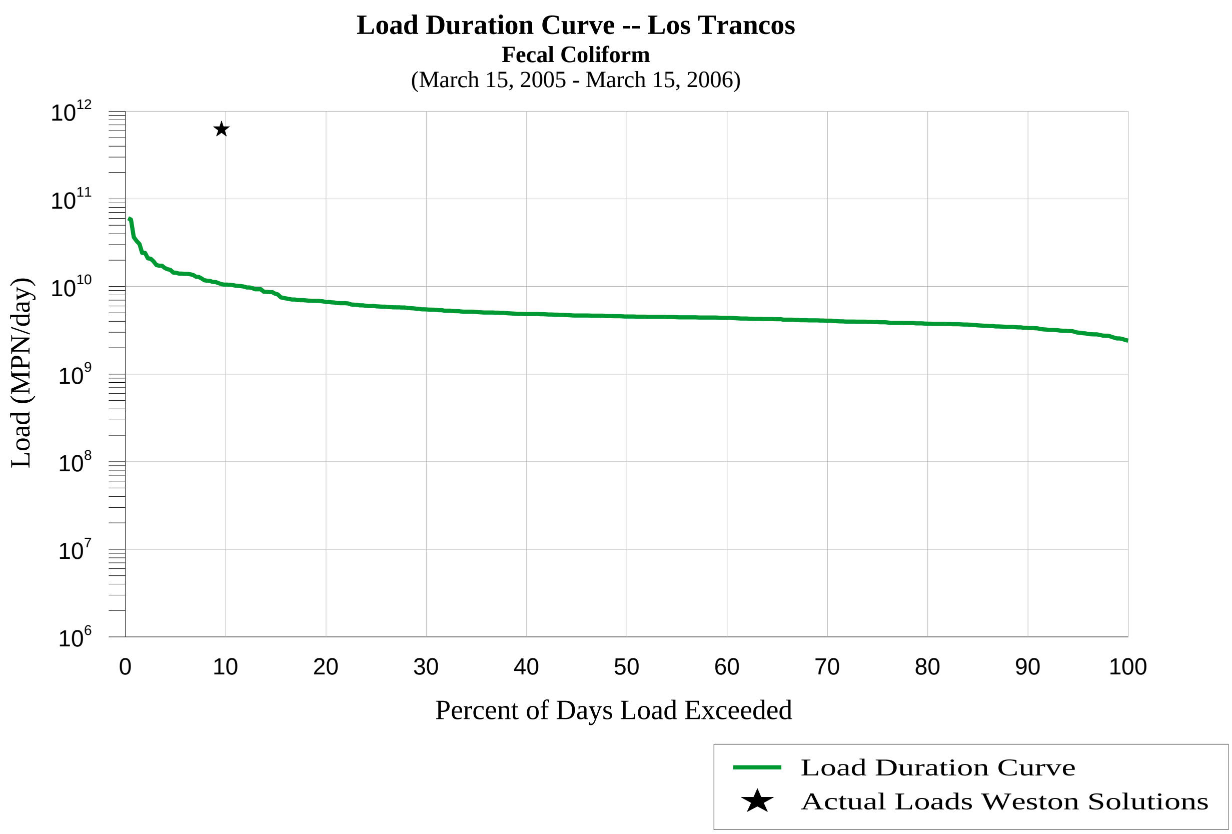
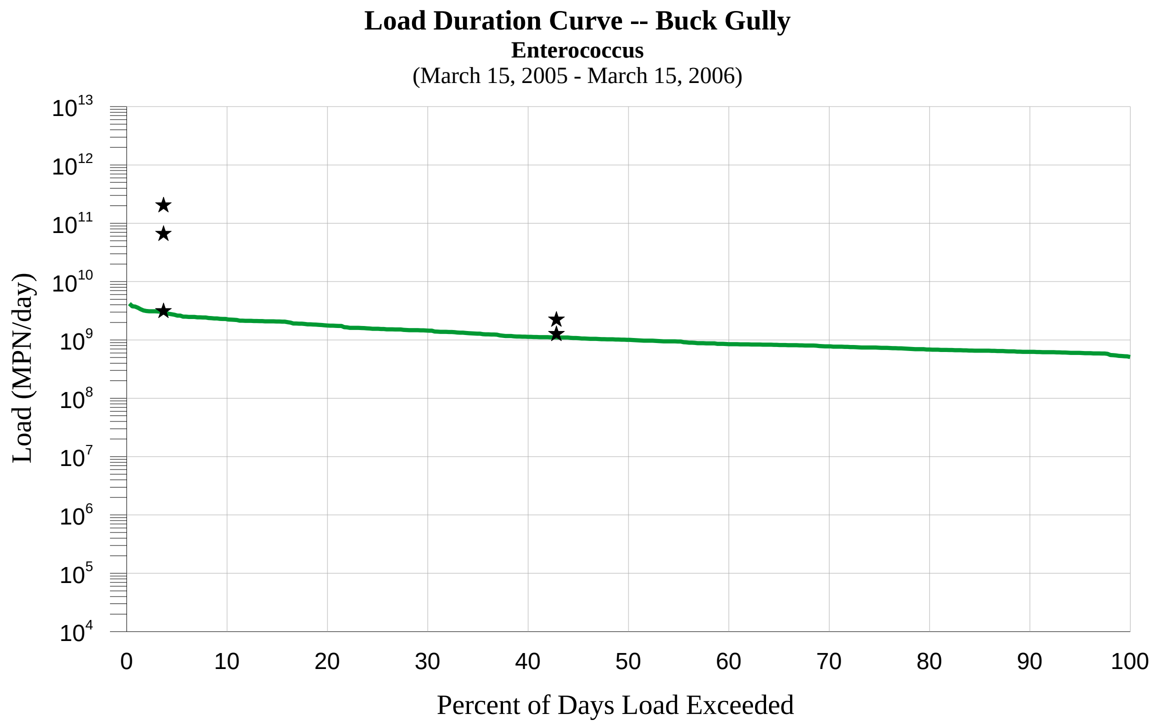


Figure 3-23. Load duration curves for fecal coliform.



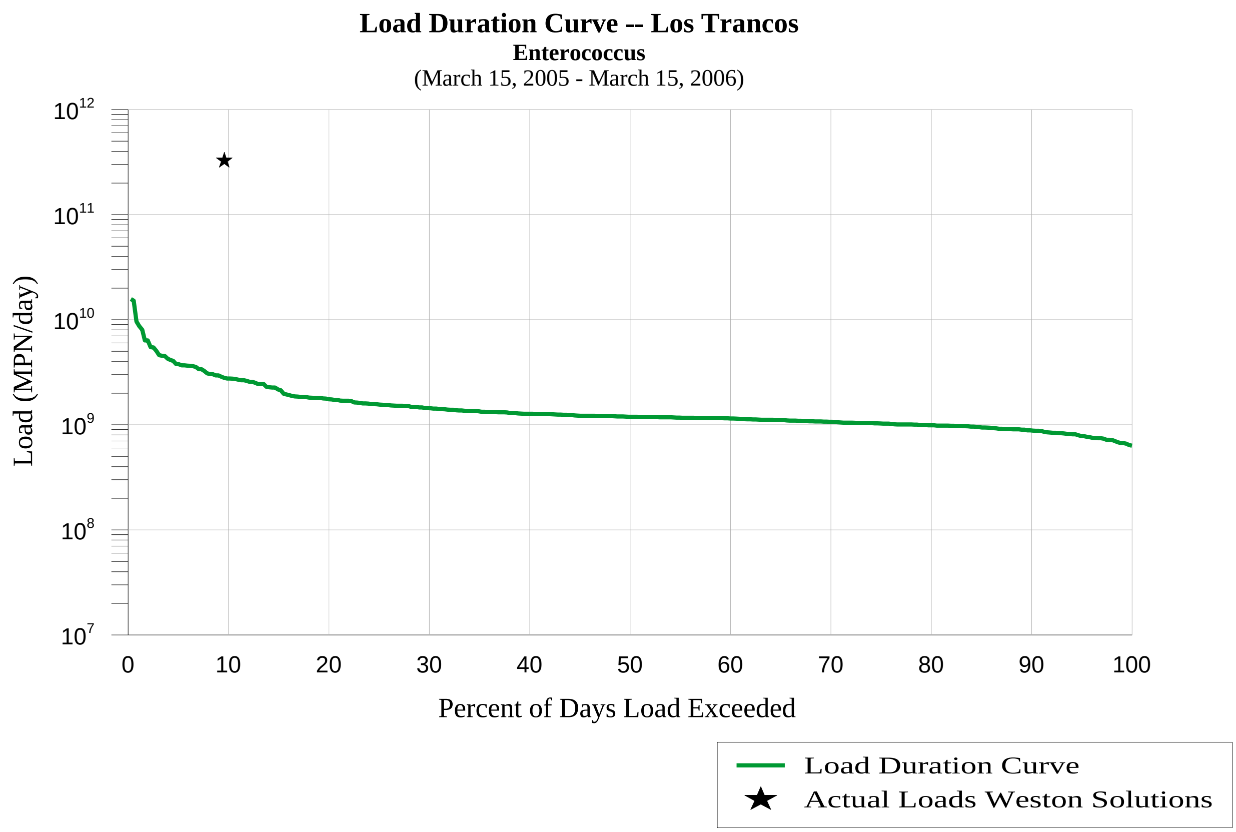


Figure 3-24. Load duration curves for Enterococcus.

Total dry, wet, and annual weather loads for dissolved metals and bacteria were estimated for all sample sites. The results are presented in Table 3-15 through Table 3-18. Most of the annual loads at Buck Gully, Pelican Point, and Morning Canyon can be accounted for during dry weather periods. Because dry weather flow at sites Morning Canyon (MCC) and Los Trancos (LTD) is diverted, no loads were calculated for the sites. It appears that much of the dry weather load for the study area can be accounted for from sites Morning Canyon (MCD) and Pelican Point (PPM), which account for approximately 77% of the total load for cadmium, 36% for copper, and 43% for zinc. Interestingly, the dry weather load for zinc at site El Moro (EMD) is approximately equivalent to the load at site MCD at 12.72 pounds, and copper is also nearly equivalent at 7.42 pounds. Bacterial densities at all sites are approximately equivalent, although at site PPM the load of 9.81 (log MPN) is about one log lower than at all other sites during dry weather.

During dry weather events, seven sites in Buck Gully were sampled. The load results of these samples (Table 3-15) indicate that loads at stations BG5 and above are not high, but proceeding downstream there is a significant increase in loading at station BG4. This load either stays consistent or drops a little before the bottom of the watershed, indicating that most of the load is acquired near sites BG4 and BG3.

Table 3-15. Results for annual dry weather loads (lbs) for dissolved metals and bacteria.

Station ID	No of Samples	Cadmium (lbs)	Copper (lbs)	Lead (lbs)	Zinc (lbs)	Fecal Coliform (log MPN)	Enterococcus (log MPN)
Buck Gully							
BGO	1	**	**	**	**	**	**
BG1	2	2.89	7.77	0.02	16.45	11.67	11.77
BG2	1	1.46	6.27	0.02	12.39	11.83	12.02
BG3	2	2.81	6.56	0.02	13.06	11.60	11.42
BG4	2	2.14	4.98	0.01	10.08	11.30	10.98
BG5	1	0.43	1.80	0.01	3.66	10.92	10.61
BG6	1	0.14	0.63	0.01	3.06	11.61	10.93
BG7	2	0.33	0.75	0.00	1.37	10.93	10.80
Morning Canyon							
MCD	1	6.19	3.55	0.01	12.10	10.63	11.71
Pelican Point							
PP1	1	0.04	0.09	0.00	0.16	10.95	10.70
PPM	1	11.69	5.04	0.27	9.63	9.81	10.68
PPW	0						
Los Trancos Canyon							
LTD*	2						
Muddy Canyon							
MCC*	2						
El Morro Canyon							
EMO	1	**	**	**	**	**	**
EMD	1	2.32	7.42	0.03	12.72	11.38	11.02

Values based on median hourly load of events (in pounds) multiplied by the number of dry weather (679) hours for the time period March 15, 2005 through March 15, 2006

*Dry weather flows are diverted at these sites

** No loads for ocean stations were calculated

Wet weather estimated loads for all sites are more consistent throughout the watershed when compared to dry weather loads (Table 3-16). Loads for cadmium range from close to zero at site PP1 to 1.09 pounds at site LTD and copper ranges from 0.25 to 2.56 pounds. There is less resolution during wet weather events of loading patterns from Buck Gully sub-watersheds compared to dry weather because samples were not taken at all seven Buck Gully sites during wet weather, only sites BG7, BG3, and BG1. However, the loads calculated from the three sites indicate that, as expected, most of the load comes in at site BG3 and remains at that level through site BG1.

Table 3-16. Results for annual wet weather loads (lbs) for dissolved metals and bacteria.

Station ID	No of Samples	Cadmium (lbs)	Copper (lbs)	Lead (lbs)	Zinc (lbs)	Fecal Coliform (log MPN)	Enterococcus (log MPN)
Buck Gully							
BGO	2	**	**	**	**	**	**
BG1	3	0.61	1.78	0.01	4.95	12.61	12.27
	3	0.54	1.94	0.04	2.24	12.70	12.62
BG7	2	0.04	0.26	0.00	0.97	11.32	11.85
Morning Canyon							
MCD	3	0.65	1.38	0.01	10.84	11.30	11.75
Pelican Point							
PP1	3	0.00	0.09	0.00	0.10	10.28	11.09
PPM	3	0.26	0.41	0.00	1.07	11.88	11.69
PPW	3	0.24	0.25	0.00	1.05	11.92	11.73
Los Trancos Canyon							
LTD*	4†	1.09	1.55	0.00	2.87	13.24	12.97
Muddy Canyon							
MCC*	3†	0.22	0.72	0.00	1.78	13.29	12.80
El Morro Canyon							
EMO	1	**	**	**	**	**	**
EMD	3	0.61	2.56	0.02	6.31	12.26	11.86

Values based on median hourly load of events (in pounds) multiplied by the number of wet weather hours (8081) for the time period March 15, 2005 through March 15, 2006

*Dry weather flows are diverted at these sites

** No loads for ocean stations were calculated

*** Bacterial Loads based upon one wet weather event

† These values include data from two Irvine Company sample events

Annual loads for dissolved metals and bacterial indicators (Table 3-17) indicate that, for cadmium, sites MCD and PPM account for the majority of loading across the study area. However, zinc loading at BG1, MCD, and EMD is nearly equivalent and copper loads at BG1 and EMD are similar at 9.55 and 9.98 pounds. It is important to note that because of dry weather flow diversions at LTD and MCC, no loads were calculated at these sites. As most of the annual load at all other sites occurred during dry weather, it is noteworthy that when comparing annual dissolved and bacterial indicator loading between sites to remember that wet weather loads account for a small percentage of annual loads at other sites. Therefore, although the annual loads at LTD and MCC are representative of conditions at those sites they may not be comparable to the dry weather dominated annual loads at other sites.

Table 3-17. Results for annual total loads (lbs) for dissolved metals and bacteria.

Station ID	No of Samples	Cadmium (lbs)	Copper (lbs)	Lead (lbs)	Zinc (lbs)	Fecal Coliform (log MPN)	Enterococcus (log MPN)
Buck Gully							
BGO	3	**	**	**	**	**	**
BG1	5	3.50	9.55	0.03	21.40	12.66	12.39
BG3	4	3.35	8.51	0.06	15.30	12.73	12.64
BG7	4	0.37	1.02	0.01	2.35	11.47	11.89
Morning Canyon							
MCD	4	6.84	4.92	0.01	22.95	11.39	12.03
Pelican Point							
PP1	4	0.04	0.18	0.00	0.26	11.03	11.24
	4	11.95	5.45	0.27	10.70	11.88	11.73
PPW	3	0.24	0.25	0.00	1.05	11.92	11.73
Los Trancos Canyon							
LTD*	4†	1.09	1.55	0.00	2.87	13.24	12.97
Muddy Canyon							
MCC*	4†	0.22	0.72	0.00	1.78	13.29	12.80
El Morro Canyon							
EMO	2	**	**	**	**	**	**
EMD	5	2.93	9.98	0.05	19.03	12.31	11.92

Values based on the sum of wet and dry weather loads for the time period March 15, 2005 through March 15, 2006

*Dry weather flows are diverted at these sites

Total metals loading for dry, wet, and annual loads was estimated and is presented in Table 3-18. In all cases, Buck Gully (BG1) has loads greater than El Morro Canyon (EMD). Proportionally, BG1 has loads for cadmium approximately twice that of El Morro Canyon, 30% greater for copper, and approximately equivalent loads for zinc. As with the dissolved metals, a majority of the constituent loading occurs during dry weather periods. The comparison of annual loads is interesting because the watershed area for El Morro Canyon is approximately twice that of Buck Gully, which resulted in a calculated flow twice that of Buck Gully. So, even with approximately double the calculated flow at El Morro when compared to Buck Gully, the loads are still less than or equal to Buck Gully. Therefore, loading is greater at Buck Gully for total metals when compared to El Morro.

Table 3-18. Results for total dry, wet, and annual loads for total metals.

Station ID	No of Samples	Cadmium (Cd)	Copper (Cu)	Lead (Pb)	Zinc (Zn)
Total Metals Annual Wet Weather Loads (lbs)					
BG1	3	1.450	4.790	0.276	7.212
EMD	3	0.661	3.352	0.311	8.410
Total Metals Annual Dry Weather Loads (lbs)					
BG1	2	4.76	4.66	0.03	16.76
EMD	2	2.21	3.82	0.05	13.79
Total Metals Total Annual Yearly Loads (lbs)					
BG1	5	6.21	9.45	0.30	23.97
EMD	5	2.88	7.17	0.36	22.20

A Pearson correlation coefficient was calculated for dissolved metals and bacteria for each of dry, wet, and annual loads and residential land use by canyon. The correlation coefficients are presented in Table 3-19. The results show no relationship between loads for any season and residential land use.

Table 3-19. Pearson correlation coefficients for percent residential land use (trace metals/bacteria) for all canyons.

Parameter	Cadmium	Copper	Lead	Zinc	Fecal Coliform	Enterococcus
Total Yearly Loads	-0.08	0.45	-0.20	0.39	0.52	0.67
Wet Weather Loads	0.47	0.49	0.55	0.15	0.51	0.63
Dry Weather Loads	-0.31	0.35	-0.39	0.38	0.55	0.41

To test for relationships in Buck Gully between dry, wet, annual loads and water use by sub-watershed, a Pearson Correlation was run and the results are presented in Table 3-20. The results show a relationship between dissolved metals for dry, wet, and annual loads and water use. Cadmium, copper, and zinc appear to be related to annual, dry and wet loads from all sites. Further investigation using regression analysis (Table 3-21) reveals that only dry weather loads are related to water use, with a significant R^2 of 0.69 for cadmium, 0.91 for copper, 0.93 for zinc, and 0.78 for Enterococcus (Figure 3-25). This relationship between water use and trace metal loads could be related to urban runoff.

Table 3-20. Pearson correlation coefficients for water usage and trace metals/bacteria for Buck Gully.

Parameter	Cadmium	Copper	Lead	Zinc	Fecal Coliform	Enterococcus
Total Yearly Loads	0.95	0.97	0.67	1.00	0.91	0.76
Wet Weather Loads	0.97	0.90	0.47	0.93	0.91	0.67
Dry Weather Loads	0.83	0.95	0.95	0.96	0.71	0.88

*Highlighted cells indicate a positive correlation between water usage and trace metals/bacteria loading

Table 3-21. Regression results water use and dissolved metals and bacteria loads.

Constituent	Annual		Wet		Dry	
	R^2	p-value	R^2	p-value	R^2	p-value
Cadmium	0.90	0.20	0.94	0.16	0.69	0.02
Copper	0.94	0.16	0.81	0.29	0.91	<.001
Zinc	0.99	0.03	0.87	0.23	0.93	<.01
Enterococcus	-	-	-	-	0.78	0.01

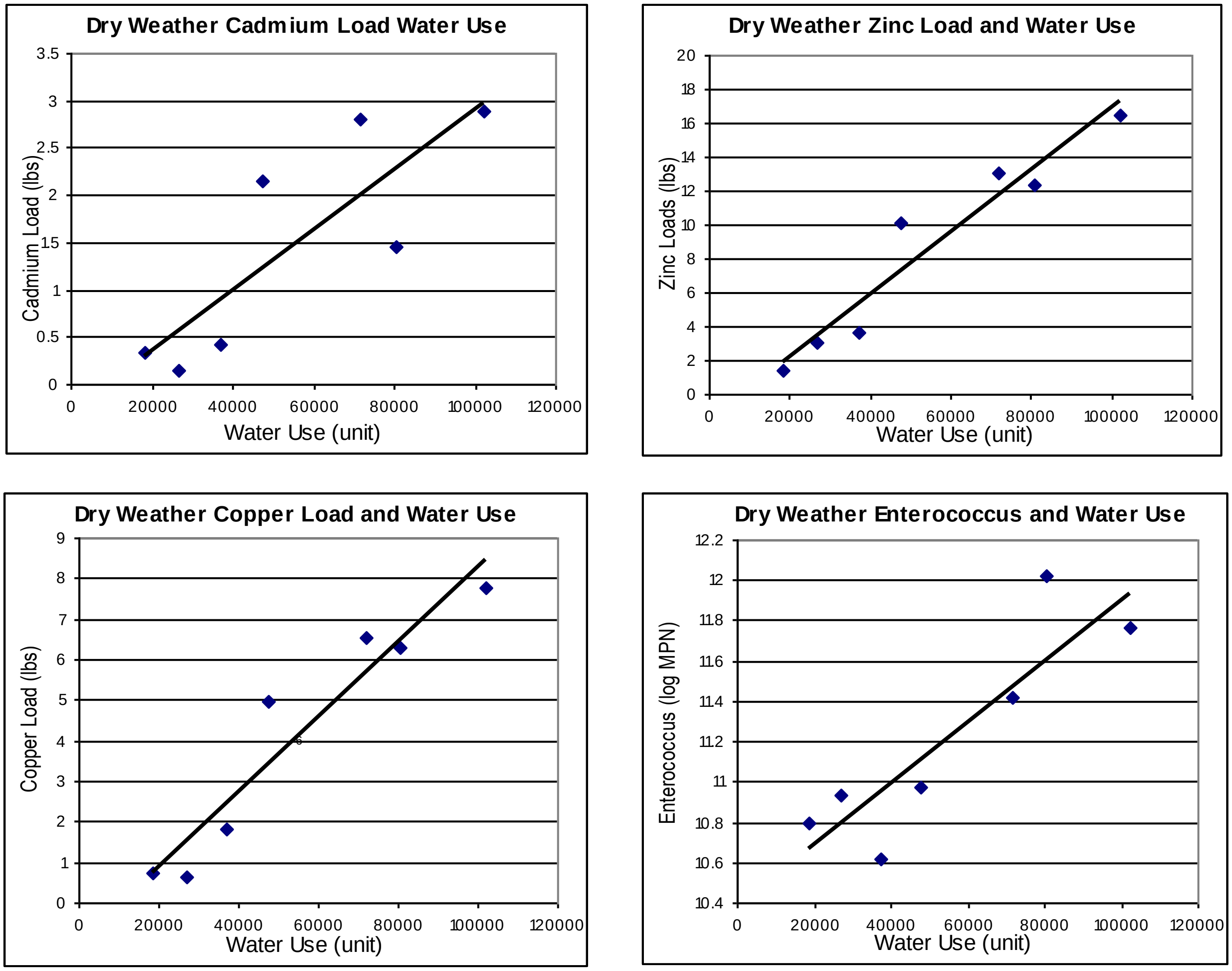


Figure 3-25. Scatterplots of dry weather loading and water use.

As mentioned in Section 2.4.2.2, dry and wet weather flows at all sites were estimated based on an average flow per acre ratio derived from the model predicted data at Buck Gully and Los Trancos. While this method ensures that loads will not be calculated based on highly variable instantaneous flows, it does bias the loads toward large watershed areas. This means that a sample location at the mouth of a large watershed, such as El Morro, will have a calculated load that may be overestimated. In fact, the calculated flows at El Morro when compared to Buck Gully are twice as high (Table 3-5 and Table 3-13). To explore the possible over-estimation of flow, and therefore load at El Morro (EMD), a comparison of annual load estimates at El Morro between modeled and flow meter flows was completed. The results indicate that the flow meter based annual loads at El Morro are approximately 5% of the model based loads (Table 3-22). This result is not surprising based on the knowledge that El Morro canyon dry weather flows are usually zero upstream of the leach fields. A flow estimation based on the watershed area of this canyon is likely to overestimate loads at this site. It would be prudent to utilize the flow data collected at this site, and the loads calculated thereby when making decisions about the constituent load of El Morro canyon.

Table 3-22. El Morro Flow Based Load Comparison.

Season	No of Samples	Cadmium (lbs)	Copper (lbs)	Lead (lbs)	Zinc (lbs)	Fecal Coliform (log MPN)	Enterococcus (log MPN)	Flow (cfs)
Model Based Loads								
Dry	2	2.32	7.42	0.03	12.72	11.38	11.02	0.72
Wet	3	0.61	2.56	0.02	6.31	12.26	11.86	2.00
Annual	5	2.93	9.98	0.05	19.03	12.31	11.92	-
Flow Meter Based Loads								
Dry	2	0.13	0.29	0.00	0.46	9.93	9.81	0.08
Wet	3	0.04	0.24	0.00	0.63	11.92	11.84	0.79
Annual	5	0.17	0.52	0.00	1.09	11.92	11.85	-

4.0 CONCLUSIONS

The Water Quality and Flow Assessment for the Newport Coastal Canyons was designed to address the following key program questions. Based on the results of the field and analytical program, the questions were addressed as summarized below:

- ***Are conditions in Buck Gully Creek, the seven other canyon streams, and the two ASBSs of the Newport Coast protective, or likely to be protective of their beneficial uses?***

The results of the Water Quality and Flow Assessment for Buck Gully and the other seven canyons indicate that water quality conditions are protective of the beneficial uses which include REC1, REC2 and MUN with the exception of fecal coliforms, and dissolved cadmium and copper. Diazinon concentrations exceeded the WQO in only one sample (furthest upstream sample in Buck Gully). The bacterial water quality criteria are based on recreational uses of the creeks and the ocean. The dissolved cadmium and copper criteria are based on the California Toxic Rule, which relates risk to potential ecological receptors in the receiving waters.

- ***What is the extent and magnitude of the current or potential problems in the eight Newport Coast canyons and the two ASBSs where these creeks flow into?***

The most frequently exceeded and widely detected exceedances of the WQOs were observed for bacteriological indicators. The concentration of bacteriologic indicators exceeded the WQO in both dry and wet weather samples. The exceedances for fecal coliform bacteria were observed for all coastal canyons for multiple storm events. Exceedances of WQO for fecal coliform bacteria concentrations were limited in dry weather samples to Pelican Point (PP1), Upper Los Trancos (LTU) and Muddy Creek (MCC). The highest concentrations were observed during the wet weather events, and generally for the first storm event. These results may indicate a possible first flush phenomenon for bacteriological indicators. The exceedances in the freshwater samples from the coastal canyons are based on the use of the more conservative WQO of 400 MPN/100ml, which is the maximum allowed for 10 percent of the samples during a monthly sampling period.

Comparisons to WQOs for ocean samples for Enterococcus and total coliforms indicated exceedances in the mixing zone samples at Buck Gully and El Morro (Enterococcus only). Although these saltwater WQO are not directly applicable to the freshwater samples from the costal canyons, the concentrations of Enterococcus bacteria exceeded this WQO in dry weather samples collected at the furthest downstream and next two upstream locations in Buck Gully, and nearly all the other canyon creek sampling locations. Concentrations of Enterococcus were highest at PP1. This WQO was not exceeded at the reference (El Morro) canyon freshwater site or at upstream locations in Buck Gully above the fifth and Poppy stormdrain discharge. Exceedances were indicated at all the canyons for the wet weather samples, with the highest concentrations generally observed for the first storm event. Similar wet weather results were also indicated for total coliforms.

Load duration curves developed for Buck Gully using the modeled annual flow rates and the applicable WQO indicated that the modeled load requirement for fecal coliform was exceeded for wet weather samples, but not for the dry weather events. These findings indicate that predicted exceedances of the load allocation for Buck Gully would occur during wet weather events in the absence of measures to reduce the overall current loads. Dry weather flows would not exceed the load allocation. For comparison purposes, the predicted load allocation for Enterococcus is estimated to be exceeded during both wet and dry flows for the concentrations detected in this assessment. As stated previously, the Santa Ana Basin Plan does not have a WQO for Enterococcus. The WQO applied for the load allocations is based on the Ocean Plan criteria that is applicable to ocean samples. Due to the limited ocean sampling, a comparison with the fresh water samples was performed to provide a qualitative evaluation of overall bacteria concentrations and loadings.

The sources of the bacterial exceedances were not specifically identified in this study, but the results indicate both natural and anthropogenic sources. The concentrations of bacteriological indicators at the downstream location in El Morro Canyon exceeded the WQOs at least once for total coliforms, fecal coliforms and Enterococci during the storm events. El Morro Canyon is approximately 95% undeveloped, with the exception of a trailer park and the Coast Highway at the mouth of the creek. Samples were also collected above the trailer park, which resulted in one exceedance for Enterococcus during one storm event. These results suggest both anthropogenic and non-anthropogenic sources of bacteria contributing to the exceedances in this and other coastal canyon watersheds. In addition, the analysis of estimated total annual loads indicated the total dry and wet weather annual loads for fecal coliforms are of the same magnitude for furthest downstream sampling point at both Buck Gully (the most developed watershed) and El Morro (least developed). The estimated annual wet weather loading for Enterococcus at Buck Gully was, however, an order of magnitude higher than the load at the reference site (El Morro) for the modeled flows, and even significantly higher when the instantaneous flow measurements are used for loading estimates. In can be therefore concluded, that with respect to Enterococcus, there are likely greater anthropogenic sources in Buck Gully compared to the reference canyon.

In addition to bacteriological indicators, dissolved cadmium concentrations exceeded WQOs in wet and dry weather flows in Pelican Point Middle Creek (PPM) and Morning Canyon Downstream (MCD). The highest concentrations for wet weather events were Pelican Point Waterfall Creek and Morning Canyon, and for dry weather samples at PPM, which was an order of magnitude greater than the concentration detected at Buck Gully. There was one exceedance of the WQO for dissolved cadmium at Buck Gully downstream (BG1) and at the upstream location at Poppy Lane (BG3) in a dry weather sample. The loading assessment for Buck Gully indicated that for the modeled flow, an exceedance of the predicted load duration curve was observed for the chronic standards for one dry weather event. An evaluation of total loads for dissolved cadmium using modeled annual flows showed the highest annual loads from Morning Canyon and Pelican Point Middle Creek, even though these are much smaller watersheds.

The source of cadmium in wet and dry weather flows was not identified, but can be from both natural and anthropogenic sources. Concentrations of dissolved cadmium detected in the reference (El Morro) canyon dry weather samples ranged from 0.87 to 2.67 μg/L. If the average of these reference concentrations were subtracted from the concentrations of 6.39 and 6.23 μg/L detected at Buck Gully BG1 and BG3, respectively, the CTR criteria of 6.22 μg/L would not be exceeded. The magnitude of the exceedances at Pelican Point Middle Creek and Morning Canyon are, however, much higher and suggest potential anthropogenic sources.

The concentration of dissolved copper was also detected above the WQO less frequently than dissolved cadmium. Exceedances of the WQO were indicated in wet weather samples from Pelican Point (PP1) and upper Morning Canyon (MCU), and in one dry weather sample at Pelican Point Middle (PPM).

Although the freshwater criteria are based on the dissolved metal fraction that is bio-available to potential ecological receptors, a comparison of the CTR for total metals was also performed. The results of this comparison concluded the predominant exceedance of the metals criteria was for total cadmium in both dry and wet samples from Buck Gully, Morning Canyon and Pelican Point watersheds. Exceedances of the metals criteria were also indicated for total copper and zinc in wet weather samples from Morning Canyon and Pelican Point (PP1 & PPW) creeks.

In comparing the concentrations of dissolved cadmium detected in the Newport coastal canyons to concentrations reported regionally, the concentrations detected in Morning Canyon and Pelican Point dry and wet weather samples are an order of magnitude and greater compared to the mean concentrations reported for the San Diego, Santa Ana Delhi and Laguna Canyon Creek (City of Laguna Beach 2006).

Evaluation of potential impact to the ASBSs was assessed through collection of ocean sample in the mixing zones of Buck Gully and at the reference canyon. The results of the mixing zone sampling during the first wet weather event indicated that total suspended solids (TSS), residual chlorine and total cadmium exceeded the Ocean Plan objectives. The high TSS was found to be associated with sediment agitation and suspension in the surf zone where the first sample was collected for safety reasons. During the second wet weather event, a second mixing zone sample was collected using procedures to reduce sediment entering the sample. The TSS concentration in this sample was well below the WQO. The source of the residual chlorine is suspected to be from treated recycled water used for irrigation in the coastal canyon watersheds. The total cadmium exceedance in the mixing zone at the discharge of Buck Gully may be from contributions from Buck Gully. However, total cadmium concentrations at Buck Gully were less than half of the detected concentration in the mixing zone sample. Furthermore, based on the total annual load analysis, greater total loads may be associated with flows from Morning Canyon and Pelican Point Middle Creek.

The results of the acute toxicity testing on the ocean and fresh water sample from the mouth of Buck Gully Creek indicated no toxic response. The only toxic effect observed from the samples was from the chronic test for kelp germination. The 50% concentration was identified as the Lowest Observable Effect Concentration (LOEC). However, this sample was collected during a storm event, which is more representative of an acute exposure than a longer term chronic condition. The specific cause of the toxicity on kelp germination can not be determined from these tests. In addition to the chemical constituents in the sample, the amount of sunlight (that can be affected by TSS) can also result in measured effects. A TIE test can be performed to better determine the potential causes of the measured toxicity effects.

- ***What is the relative urban runoff contribution to the problems in the eight coastal canyons and the ASBSs?***

Based on the assessment of estimated total loads for dissolved metals (cadmium, copper, and zinc) using the modeled flow rates, annual dry weather loads for Buck Gully are approximately 80 percent (refer to Table 3-15 and Table 3-16) of the total annual load. Even greater percentages of total loads are estimated for Morning Canyon and Pelican Point Middle Creek, which have higher total loads for cadmium than Buck Gully. These results demonstrate that the dry weather flows of which dry weather urban runoff is a portion, is a predominant source of total loads of heavy metal constituents that exceed WQO.

The results of the analysis of contributions to the total estimated annual load for bacteriological indicators indicated that wet weather flows contribute the greatest portion of total load. The opposite of the conclusion for dissolved metals. The load contribution from wet weather flows was an order of magnitude higher than those from the dry weather flows for both fecal coliform and Enterococcus. This is due to the significantly greater concentrations of these indicators in wet weather samples. The bacterial indicator results for the first wet weather event are generally an order of magnitude higher at nearly all the locations in the Newport Coast Watershed. These results indicate a possible first-flush phenomenon.

The portion of dry weather flow that is associated with direct urban runoff will vary during the day and location within and between the coastal canyons. The results of the dry weather source identification study indicated that for the time period investigated (during the highest observed flows in the creek) the contribution from direct runoff was much less than the seepage component. The preliminary results of the Groundwater Seepage Study by Todd Engineers indicates that due to significant increases in the use of imported water for irrigation, groundwater seepage has also increased especially at the lower portions of the deeper canyon creek where the channel cuts reach the groundwater table. Increase irrigation in Buck Gully, Morning Canyon and Pelican Point watersheds has resulted in a groundwater mound that is intercepted by the canyon creeks in Buck Gully and possibly Morning Canyon.

- ***What are the sources to urban runoff that contribute to the water quality concerns in the largest and most developed canyon, Buck Gully?***

Within the Newport coastal canyon watersheds, it can be reasonably assumed that the vast majority of metals contributed to the canyon creeks and ocean are from non-point sources. There are no direct discharges from wastewater treatment plants or groundwater treatment facilities within these watersheds. Potential non-point sources of heavy metals in urban runoff based on a study conducted in Santa Clara California concluded that urban runoff from roads was the largest contributor (Woodward-Clyde 1998). The metals from roadway runoff included cadmium (tires), copper (brakes and tires), lead (brakes, tires, fuels and oils) and zinc (tires, brakes, auto frame). Secondary contributions were cited to include contaminated sediments, atmospheric depositions and miscellaneous sources, such as phosphate fertilizers (OECD 1994, ERL 1990), composts applied to plants and grasses (Agriculture Canada 2005), fungicide for golf courses and home lawns (EPA 2006b), and antifouling paints from boats. All these non-point sources of heavy metals including cadmium and copper exist in the Newport coastal canyon watersheds.

The findings from the dry weather source investigation at Buck Gully indicated the largest relative flow was found in a drainage channel that enters the creek between Spyglass Ridge Community (BG3) and the outlet structure at Fifth and Poppy Streets (BG4). The drainage channel collects urban runoff from the sub-drainage area that includes a portion of the Pelican Hill Community. This flow was also the source with the highest nitrate and phosphate values. The residences within this sub-drainage area also correspond to properties identified with higher water consumption than the communities to the north. This community has been identified by the City for promotion of the use of smart irrigation systems to lower water consumption. A decrease in irrigation within this community will reduce dry weather flows in Buck Gully and should improve overall water quality in the receiving channel and in the ASBS.

Based on the Draft Groundwater Seepage Study, the use of imported water for irrigation has resulted in a groundwater mound in the Buck Gully, Morning Canyon and Pelican Point watersheds. Reduction of irrigation using these ET controllers would reduce infiltration and lower the groundwater mound resulting in lower contributions to groundwater seeps and dry weather flows in the lower portions of the canyons. The Groundwater Seepage Study also suggested that the quality of the dry weather flows is significantly influenced by the quality of the infiltration waters and the groundwater seeps. Analysis of groundwater seeps by Todd Engineers for chloride and sulfate indicated higher concentrations of these constituents downgradient of potential sources compared to upstream samples. The Draft Groundwater Seepage Report indicated that the golf course at Pelican Point may increase concentrations of these constituents through the use of soil amendments and provide a migration pathway through irrigation.

Another source found in the section between BG3 and BG4 is at the catchment basin at Poppy Lane and 5th Avenue. Inside the locked fence, a four inch PVC pipe is harnessed inside the larger 48 inch RCP and was continuously discharging water. The water quality results here are lower for nitrate and phosphate, but had the highest ammonia value of 2.0 ppm. The City has also targeted the Fifth and Poppy Streets discharge for upgrades and possible treatment of dry weather flows. This project is scheduled for implementation in 2007.

The third identified source of direct dry weather flows is just upstream of BG5 and is a tributary entering the channel from the southeast bank. This flow has been observed as a continuous flow since the first dry weather event. However, during a visit on November 21, 2005, the flow had ceased.

Additional sources of dry weather flows may be present through the dry weather period that were not observed during the source identification study or during the two dry weather events. The overall conclusion of the dry weather source identification program was that the dry weather flows observed in Buck Gully were not predominantly from direct urban runoff, but rather from groundwater seepage into the stream channel from either alluvial deposits along the stream bed and/or from groundwater discharges where the channel cuts below the groundwater table. This conclusion is consistent with the conclusions of the Groundwater Seepage Study which concluded that a significant portion of the base flow was from groundwater seepage as a result of infiltration of imported irrigation waters. The estimation of total annual flows as discussed in the previous item needs to be further investigated with the assumption used for the groundwater seepage study to better define the urban run off contributions.

The results of the Pearson Correlation analysis on water usage and the estimated loads for metals (cadmium, copper and zinc) and bacteria in Buck Gully indicated a strong relationship between the sub-drainage area water use and total loads. The conclusion from these results is that a relationship exists between high water usage within a sub-drainage area and the calculated loadings for constituents that were observed to exceed WQO in wet and dry weather samples. This can be taken further in the recommendation to prioritize measures that reduce water usage in Buck Gully and the other coastal canyons in order to reduce overall loading of constituents that may impact the beneficial use of the receiving waters of the coastal canyons and ASBSs.

- ***Are conditions in the eight coastal canyons and two ASBSs getting better or worse?***

The results of the Water Quality and Flow Assessment provide a baseline in which trends in water quality and loadings from the costal canyons and conditions in the two ASBSs can be evaluated. This water quality baseline will be used to assess the effectiveness of urban runoff reduction and water quality improvement projects planned and underway by the City of Newport Beach. The City has been implementing an incentive program for homeowners to install smart irrigation systems to reduce imported water use that based on the finding of the Groundwater Seepage Study (Todd Engineering 2006) and this assessment is a significant portion of groundwater recharge and dry weather flows in the coastal canyons evaluated (Buck Gully, Morning Canyon and Pelican Point). Best Management Practices to reduce canyon erosion and improve overall water quality in Buck Gully are also planned. These BMPs will include grade controls and natural treatment systems that will capture and treat dry weather flows and portions of the wet weather flows. The City is pursuing funds under the Consolidated Grant program (2004-2005) for the implementation of these measures along with effectiveness assessment monitoring. These planned monitoring programs will provide long-term data in which trends in water quality and biological health can be assessed.

The findings of the sampling and analysis of this Assessment will be used to establish the baseline condition in the two ASBSs. Whereas this Assessment provides baseline water quality and toxicity data in the ASBSs and coastal canyon creeks that discharge into these areas, biological and additional toxicity studies are planned at the Newport Marine Refuge Area to further assess current conditions. The biological surveys of the rocky intertidal area at Little Corona will be conducted as part of the Integrated Coastal Watershed Management Plan project. Data on species numbers and diversity will be obtained to develop a baseline model to assess current baseline conditions for comparisons to reference sites and future surveys. Future surveys are planned under the Implementation Grant project to assess the effectiveness of the implemented measures.

The long-term trend in regional bacteria concentrations has been studied by others and can be used to assess potential trends and sources of bacteria concentrations and observed exceedances of the WQO in the Newport Coastal canyons. Flow Science, in a report prepared for the Irvine Company, reviewed historical bacteriological data from Orange County, parts of LA County, and some freshwater bodies in the Santa Ana region (Flow Science 2005). A comparison was made of the bacteria data from 1986 to 2005 and the land-use data for the same time frame in the Newport Coast watersheds. The results indicate that although bacteria in storm water runoff may be elevated within urban storm drain systems, the level of development within these watersheds has little, if any, effect on the concentrations of indicator bacteria in the receiving waters. Further, the results suggest that bacteria concentrations in creeks may decline as the level of development increases, and bacteria concentrations in runoff from developed watersheds may be lower than runoff from creeks in less developed coastal areas.

Historical trends also show that across the entire watershed, wet weather samples have higher concentrations than dry weather samples; however, data from some locations show the opposite trend. For example, at Pelican Point Creek, dry weather concentrations for Enterococci and fecal coliforms are higher than wet weather concentrations. At the Emerald Bay Drain, south of the study area, fecal and total coliform dry weather concentrations are significantly greater than wet weather concentrations.

In addition, the time series plots referenced in the Flow Science survey indicate that concentrations of indicator bacteria are not increasing over time. This indicates that the bacterial loads from the Newport Coast canyons may be from natural sources within the canyons. The Laguna Beach Watershed Management Plan sites a bacteria source tracking study completed in Aliso Creek, south of the Newport Coast watershed addressing this issue. The Aliso Creek watershed also has bacteria levels that historically exceed water quality thresholds. The results of the source tracking study indicate few, if any, human sources of bacteria. To verify these findings, further bacterial source tracking studies are recommended.

5.0 RECOMMENDATIONS

- Additional Continuous Flow Measurements – In comparing loads across the Newport Coast watersheds, limitations were set on the Pelican Point watersheds and Morning Canyon due to limited flow data. If continuous monitoring were to be installed, comparative loadings could be more accurately assessed for these canyons. Because concentrations of constituents, such as metals, are frequently exceeded in these canyons, the load duration curves from the more accurate flow data can confirm the conclusions in this report that these middle canyons contribute equal of greater total constituent loading to the ASBSs. Measurements of continuous flow at Buck Gully and El Morro should also be maintained to better model annual flows and loading estimates. The flow monitoring point at Buck Gully should also be moved farther upstream where the channel is more stable and a weir structure to accurately measure flows can be installed and maintained. The observed drift in the flow measurements at El Morro canyon should also be further investigated and flow measurements collected and reassessment to provide greater accuracy in the annual flow estimates. Total load estimates for El Morro should be recalculated based on this flow data for comparison to the other canyons and establishing a natural background load.

- Effectiveness Assessment of Irrigation Controllers – The information obtained from the dry weather source identification study should be used to both implement targeted irrigation reduction programs through the installation of weather-based controllers, and to conduct effectiveness assessments of these measures. The City is undertaking these management measures in the Pelican Hill community. The City is currently installing flow measurement instruments and will be collecting samples for analysis at the approximate location of the largest dry weather discharge (BG3-4) identified during the source identification study in order to assess the effectiveness of the management measures. This work is being conducted in cooperation with a similar study by the Irvine Ranch Water District.

- Bacteria Source Tracking – The source of bacteriological indicators in the canyon should be conducted to determine if the sources are anthropogenic or natural background. Studies conducted in the Elijo Creek drainage area indicate a significant contribution from natural sources in the Laguna Canyon watershed. Due to the 303d listing of Buck Gully for bacteria, the source tracking studies should first focus on this watershed using El Morro as a reference site. The objective of the source tracking would be to identify the sources and potential measures to reduce the loading of bacteria from anthropogenic source to the maximum extent practical. Confirmation of the first flush phenomenon and development of pollutographs for bacteriological indicators should also be performed to provide data to develop a design storm for potential Best Management Practices to reduce bacteria loadings.

- Investigation of Potential Sources and Percent Contribution of Dissolved Metals in Buck Gully, Morning Canyon and Pelican Point Creeks – In order to develop and prioritize management measures to reduce the concentration and loading of dissolved cadmium and copper to the ASBS from these drainage areas, an investigation of the potential sources and percent contributions is recommended. The results of the Pelican Point Community sampling program conducted in 2006 can also be used for this evaluation. The results are presented in Appendix F.

- <u>Confirmation of Chronic Toxicity Tests and Assessment of Long-Term Effects from Total Cadmium on Sensitive Species</u> – The exceedance of the Ocean Plan criteria for total cadmium at the mixing zone at the discharge of Buck Gully and the chronic toxicity response in kelp germination should be further assessed through focused toxicity testing and possible longer term bioaccumulation studies on specific and sensitive species in order to determine if cadmium from stormwater and dry weather flows is impacting the ASBSs. These studies are planned as part of the planning grant activities for the Integrated Coastal Management Plan.

- <u>Evaluate Potential Best Management Practices to Reduce Dry Weather Flows and Groundwater Seepage into the Coastal Canyons</u> – The results of this assessment indicate that dry weather flows are a significant contribution to total heavy metal loadings. BMPs that reduce dry weather flows will also reduce overall total loadings into the canyon creeks and to the ASBSs. The City is implementing programs to reduce water usage in the coastal canyons. The City is also applying for a Consolidated Implementation grant to install additional smart irrigation controls on residential properties through financial incentives with the goal of reducing irrigation and subsequent dry weather flows. These and other BMPs will also be evaluated and prioritized as part of the watershed management plans being developed for Buck Gully and the Coastal Canyons under ongoing planning grant projects.

- <u>Further Investigate Sources of PAHs and Dioxins</u> – PAHs and dioxins are known constituents of concern in the environment. Because there is not an obvious source of PAHs or dioxins currently in the area and they are both found in the reference canyon, an investigation into possible historical sources is needed. Discussions with David Pryor at Crystal Cove State Park indicate that there are prescribed burns of grassland areas to control invasive plant species as well as accidental wildfires.

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